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China's Growing Energy Demand: Implications for the United States

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Abstract

Growing rapidly in recent decades, China's demand for energy has nearly doubled since 2005—making China the world's largest consumer of energy. That growth and the energy policies that China pursues increase the level and possibly the volatility of some energy prices, reduce the competitiveness of U.S. manufacturing firms in relation to Chinese firms but provide benefits for U.S. consumers, and increase greenhouse gas emissions. This paper examines trends in China's energy consumption, the implications of those trends for U.S. households and businesses, and policy options that might help minimize adverse effects.

Note

Numbers in the text, tables, and figures may not add up to totals because of rounding.

Contents

Figures

I. Introduction and Summary

In 2010, China surpassed the United States to become the world's largest energy user. China consumed more coal and renewable energy but less oil, natural gas, and nuclear power. By 2013, China consumed 25 percent more energy than the United States, including burning more than three times as much coal, and the U.S. Energy Information Administration (EIA) projects that by 2040 China will consume more than twice as much energy as the United States. That growth and China's energy policies affect U.S. households and businesses in at least three ways:

- Increasing the level and possibly the volatility of some energy prices,
- Reducing the competitiveness of U.S. manufacturing firms in relation to Chinese firms while benefiting U.S. consumers who pay lower prices because of Chinese subsidies for manufacturing, and
- Increasing greenhouse gas emissions.

This paper examines those effects and assesses policy options to address the adverse effects.

China's growing demand for energy affects some U.S. energy markets; in particular, China's oil imports put upward pressure on oil prices and may increase their volatility. Because the market for oil and its refined products is global, increased demand in one part of the world without a commensurate increase in supply will tend to raise global market prices. (By contrast, markets for coal and natural gas tend to be regional, which largely insulates U.S. consumers from the effects of China's increased demand for those commodities, although the natural gas market may become more interconnected.) That upward pressure on oil prices creates an incentive for some firms to produce oil that was previously uneconomical to produce. Over the past decade, much of the increase in global oil production occurred in the United States and Canada, which tend to be more stable suppliers of oil than other oil-producing countries. Some oil-producing parts of the world experience more periodic and unexpected interruptions due to war, inadequate infrastructure, or the complexity of production. To the extent that additional increases in global production come from areas that are more likely to be disrupted, the world price of oil would probably be more volatile. Policies to address higher or more volatile oil prices could give U.S. consumers more flexibility in using oil-based transportation or could reduce demand or increase supply of oil and its refined products.

The Chinese government uses two types of energy subsidies that affect the competitiveness of U.S. businesses (and businesses of other countries) in similar markets. Some subsidies promote renewable energy to reduce pollution from burning fossil fuels, whereas others protect Chinese businesses from high fuel prices. The first subsidy type supports developing renewable energy technologies by lowering the cost to manufacture them in China. Such subsidies put U.S. businesses that also produce renewable technologies at a competitive disadvantage, even though the United States also offers subsidies for renewable forms of energy, because the United States provides fewer subsidies. Moreover, such subsidies—whether by the Chinese government or the U.S. government—foster lower emissions of greenhouse gases. The second subsidy type fixes the price of electricity, natural gas, and refined petroleum products below the competitive market price—the largest amount in percentage terms is for electricity. That reduction subsidizes electricity-intensive manufacturing of, for example, chemicals, aluminum, and steel. Although its effect on competitiveness is probably small (and its effect on the

competitiveness of businesses in other countries could be larger than the effect on U.S. businesses), some researchers found that the subsidy reduced competitiveness for electricity-intensive U.S. firms competing in similar export markets.

In some cases, antidumping and countervailing duties already address the effects of those subsidies in the U.S. domestic market. U.S. policies that encourage China to reduce both types of subsidies would also probably benefit U.S. exports (or other exporters in other countries) that involve renewable technologies and energy-intensive goods while at the same time possibly raising prices for U.S. consumers of those technologies and goods. Policies that encourage China to reduce subsidies for renewable technologies and other sources of energy that produce low emissions would lead to higher greenhouse gas emissions, while policies that encourage China to reduce subsidies for other sources of energy that have higher emissions would reduce greenhouse gas emissions. Other Chinese policies, including currency devaluation, low-interest loans to Chinese firms, and reduced prices for manufacturing inputs, may have a larger effect on the competitiveness of some U.S. firms. Those policies are not specific to energy, however, and thus fall outside the scope of this paper.

Much of China's growth in energy consumption will occur through increased burning of fossil fuels, which generates greenhouse gas emissions that accumulate in the air and oceans. Experts agree that if this process continues unabated—coupled with widespread changes in patterns of land use—climate and ocean conditions throughout the world will experience extensive, unpredictable changes, resulting in potentially serious and costly effects on people and ecosystems around the world. Efforts to reduce the emission of greenhouse gases would be more effective if they included China and thus encapsulate a large share of all emissions. Although China has begun to enact policies to reduce emissions, the United States could pursue policy options to encourage China to further those efforts. Such policies include offering Chinese firms technical assistance to develop new technologies or disseminate existing low-emission technologies. If the United States implemented a policy that set a price on carbon emissions, it could also consider incorporating a provision that would allow U.S. firms to comply by using credits that correspond to reductions in emissions that were not subject to the price, including reductions made outside the United States. Those credits would serve as a financial incentive to reduce emissions in China. Also, as part of a policy that would set a price on carbon emissions, the United States could consider implementing an equivalent tariff on carbon-intensive goods and services imported from China and other countries.

The rest of this paper proceeds as follows. Section II further describes China's growing use of energy and the accompanying policies. Section III describes how that growing energy use affects U.S. households and businesses. Section IV discusses policy options to reduce the impact on U.S. households and businesses.

II. Growth in China's Energy Consumption and Imports

China became the world's largest user of energy in 2010 and is expected to remain in that position for the foreseeable future.[1] Energy use in China has grown along with rising incomes and increasing industrial

[1] Energy Information Administration, *International Energy Outlook 2013* (July 2013), www.eia.gov/forecasts/archive/ieo13/.

output in China (see Figure 1).[2] As a result of rising Chinese incomes, Chinese people generally consume more energy. Similarly, increases in the value added—the difference between the value of inputs and the value of outputs—by Chinese firms also contributed to increases in energy usage in China. Some of that increase in value added would be for consumption in China and some for export.

An ongoing rural-to-urban population shift drives the growth in incomes and the accompanying changes in energy demand.[3] The growing urban population demands new vehicles and new roads, raising the demand for energy in the transportation sector. Even so, the use of energy per person in China was only about a quarter of the energy per person used in the United States, suggesting that China could consume significantly more energy in the future as Chinese living standards continue to rise. Accordingly, the U.S. Energy Information Administration (EIA) projects that by 2040 Chinese use on a per capita basis will be about 60 percent of the estimated U.S. rate.

Separately, the industrial sector's increased output drives the high demand for electricity, refined petroleum products, and materials that are energy intensive to produce, such as chemicals, steel, and aluminum. Some of that increase in industrial output is for domestic consumption and reflects growing incomes in China. However, some of that rising industrial output is for production exported from China, reflecting demand from those countries rather than China. To the extent that rising energy consumption in China is due to growing exports, the effects of China's consumption on energy markets and greenhouse gas emissions are also linked to countries that are importing energy-intensive goods from China. As a result of both rising incomes and increasing industrial output, total energy consumption in China nearly doubled between 2005 and 2013.

Because energy production in China has not kept pace with the growth in its use, China has become one of the world's largest importers of energy. In response, the Chinese government has taken steps to increase the availability of energy. The government has also advanced policies to meet other energy-related objectives, such as reducing emissions and limiting any market-driven increases in energy prices. The extent to which China's growth in energy demand or associated policies affect U.S. energy users varies with the types of energy used.

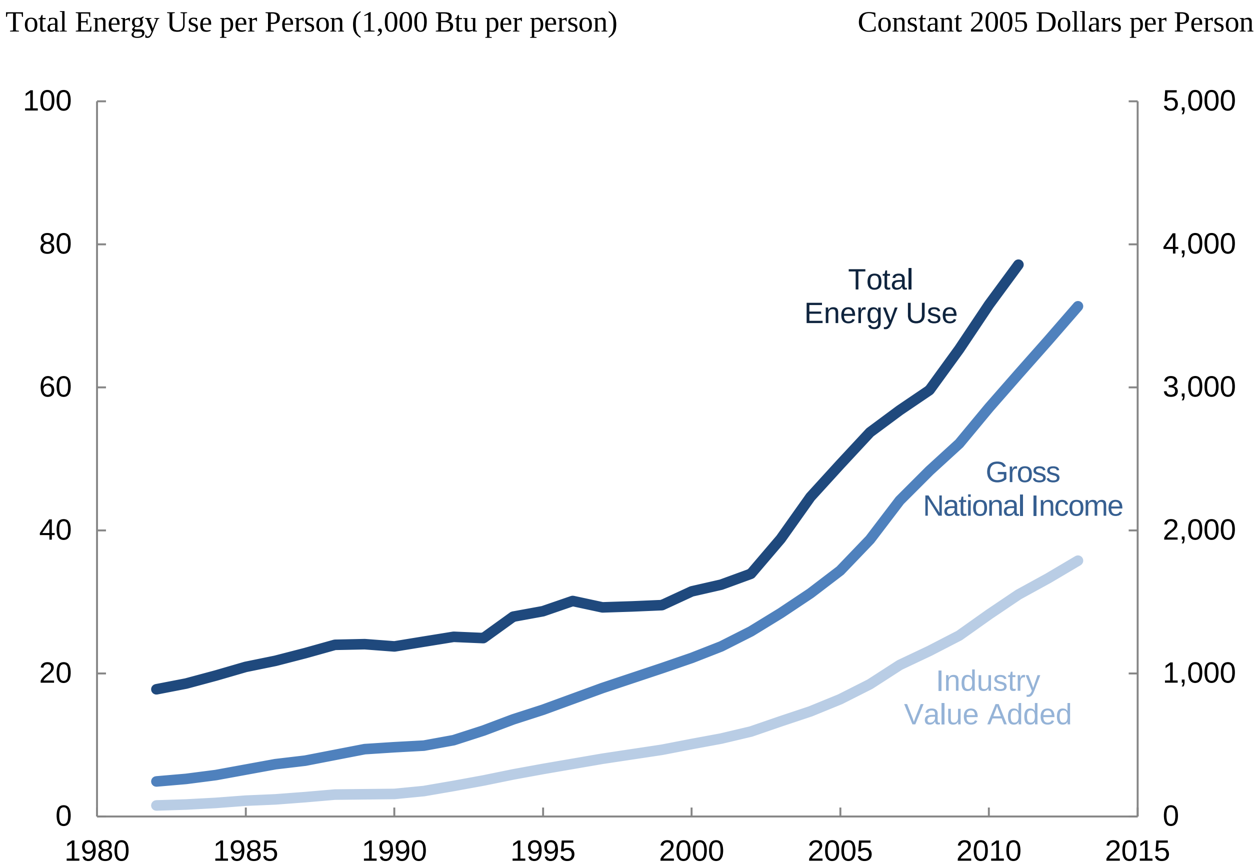
Energy Use in China and Policies to Increase Energy Supply

In 2013, China consumed roughly 118 quads (1 quad is 1 quadrillion Btu, or British thermal units) of energy primarily from coal (68 percent) and oil (18 percent), with the remaining 14 percent from renewable sources, natural gas, and nuclear energy. That same year, the United States consumed roughly 96 quads of energy, consisting of oil (37 percent), natural gas (27 percent), and coal (19 percent), with the remaining 17 percent divided equally between nuclear and renewable sources (see Figure 2). With the relative domestic availability of each energy source in China and the United States, both countries have a similar mix of energy imports, with oil as the primary energy import (see Figure 3).

[2] Between 2003 and 2013, China's population also grew, but only half as fast as the U.S. or world population.

[3] Congressional Budget Office, *China's Growing Demand for Oil and Its Impact on U.S. Petroleum Markets* (April 2006), www.cbo.gov/publication/17702.

Figure 1.
Per Capita Total Energy Use and Gross National Income in China, 1982–2013

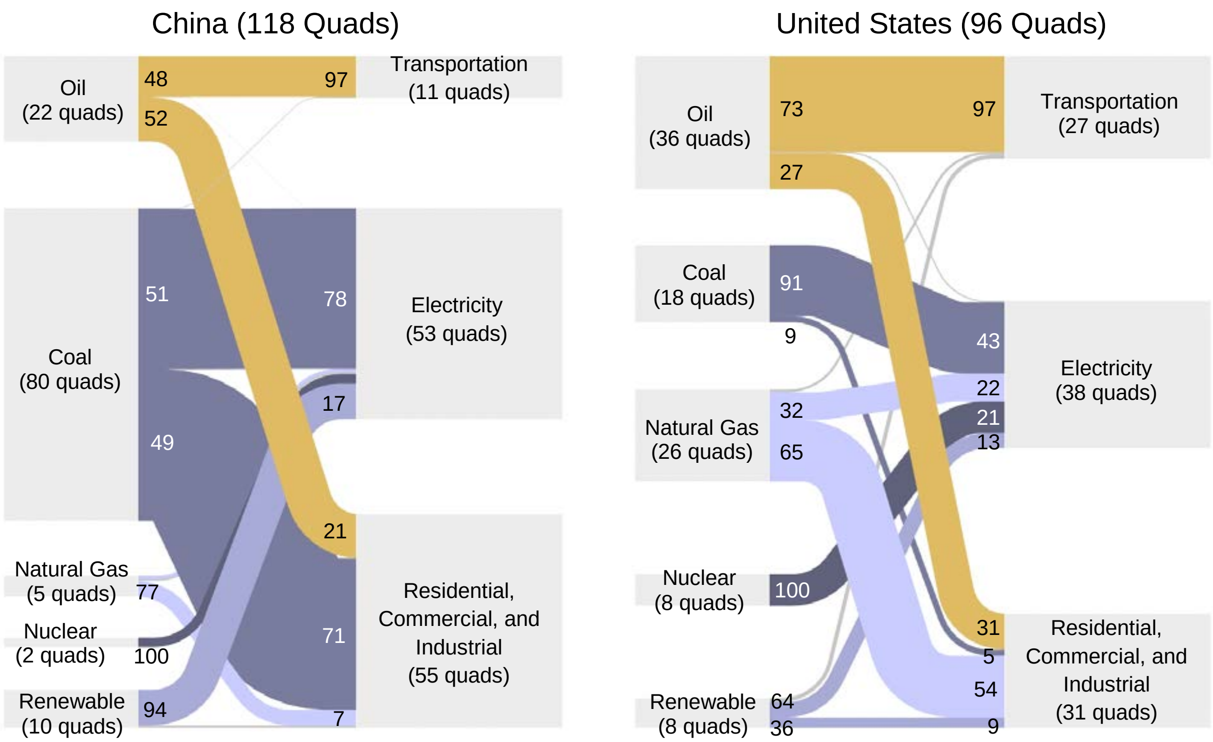


Source: Congressional Budget Office, based on data from the Department of Energy, Energy Information Administration (www.eia.gov), and the World Bank.

China's increasing volume of energy imports affects U.S. energy users to the extent that firms in both countries purchase energy in the same market. In general, a single world market for oil exists, resulting from the extensive network of pipelines, shipping, and other options for transporting oil around the world. Thus, oil has a single world price, after accounting for the quality of that oil and the cost of transporting it to the marketplace. China's increased demand for imported oil raises the price of oil and refined oil products for U.S. energy users. By contrast, the high cost of transporting coal, natural gas (other than through pipelines), or the power generated from nuclear energy or renewable sources limits their markets to geographically bounded regions, such as North America or Southeast Asia. (Figure 4 shows the interconnectedness of oil prices around the world and the regional nature of coal and natural gas prices.) Consequently, China's increased demand for those other energy sources affects U.S. energy users less than China's demand for oil.

Figure 2.
Energy Flows in China and the United States, by Source of Energy and Energy-Consuming Sector, 2013

Percent



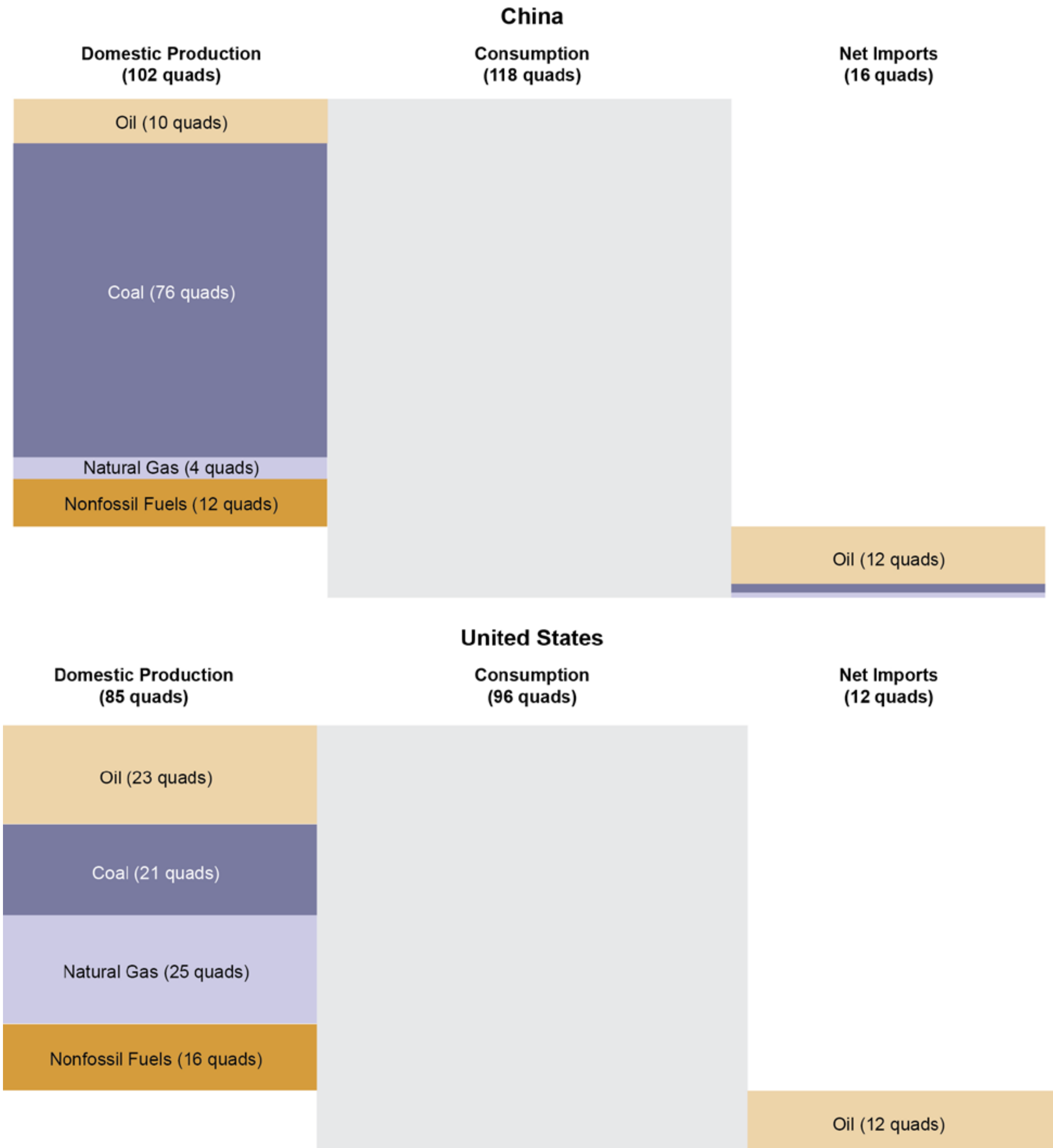
Source: Congressional Budget Office, based on data from the Department of Energy, Energy Information Administration (www.eia.gov).

Note: One quad represents 1 quadrillion British thermal units (Btu). Unlabeled flows represent amounts of less than 10 percent.

Oil Use in China. In 2014, China was the world's second-largest consumer of oil, after the United States, but the largest importer of oil. EIA predicts that China's oil consumption will increase by almost 27 percent over the next decade, far outpacing increases in production in China (see Figure 5).[4] Underlying the rapid growth in oil consumption is the increasing demand in China for vehicles fueled by refined oil products such as gasoline or diesel. Per capita use of oil in China is still much lower than that in the United States. China has only 69 motorized vehicles per 1,000 people, compared with 786 per 1,000

[4] Energy Information Administration, *International Energy Outlook 2014: World Petroleum and Other Liquid Fuels* (September 2014), Table Browser, www.eia.gov/oiaf/aeo/tablebrowser/.

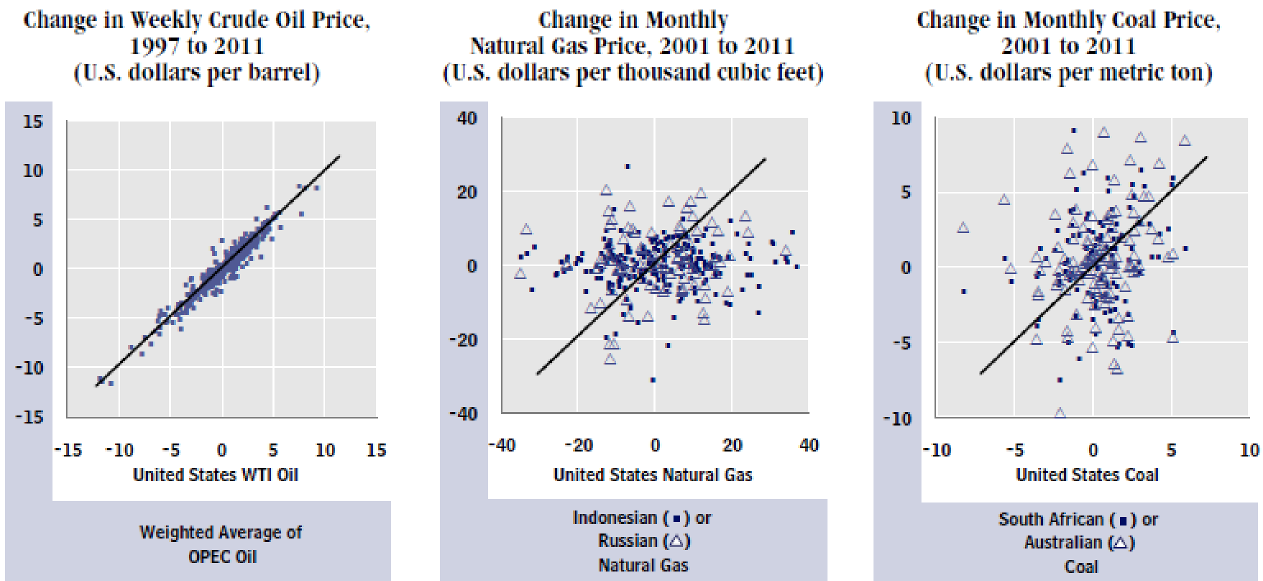
Figure 3.
Sources of Domestic Fuel Consumption in China and the United States, 2013



Source: Congressional Budget Office, based on data from the Department of Energy, Energy Information Administration (www.eia.gov).

Note: Numbers may not add up to totals because of rounding. One quad represents 1 quadrillion British thermal units (Btu). Unlabeled flows include the following: for China, imported coal (2 quads), imported natural gas (1 quad); for the United States, imported natural gas (2 quads), exported coal (3 quads).

Figure 4.
Comparison of Changes in Prices for Crude Oil, Natural Gas, and Coal in the United States and Other Countries



Source: Congressional Budget Office, based on data from the Department of Energy, Energy Information Administration, "World Crude Oil Prices," July 13, 2011 (for oil prices); and Bloomberg (for monthly data on prices for coal and natural gas).

Notes: The diagonal lines through each graph at 45 degrees indicate when changes in prices in the markets being compared correspond exactly.

For natural gas, U.S. data are for Henry Hub natural gas, Russian gas is for the price of natural gas delivered to the border of Germany, and Indonesian natural gas is for liquefied natural gas delivered to Japan. U.S. coal is a representative coal produced in the United States, South African coal is that produced in Richards Bay, and Australian coal is an index of all thermal coal in Australia.

OPEC = Organization of Petroleum Exporting Countries; WTI = West Texas Intermediate.

people in the United States.[5] China therefore has roughly 10 percent of the U.S. per capita number of motorized vehicles. By 2040, China is expected to increase the number of motorized vehicles per capita to about 40 percent of that of the United States. China would then have more total vehicles than the United States (although fewer per person).[6]

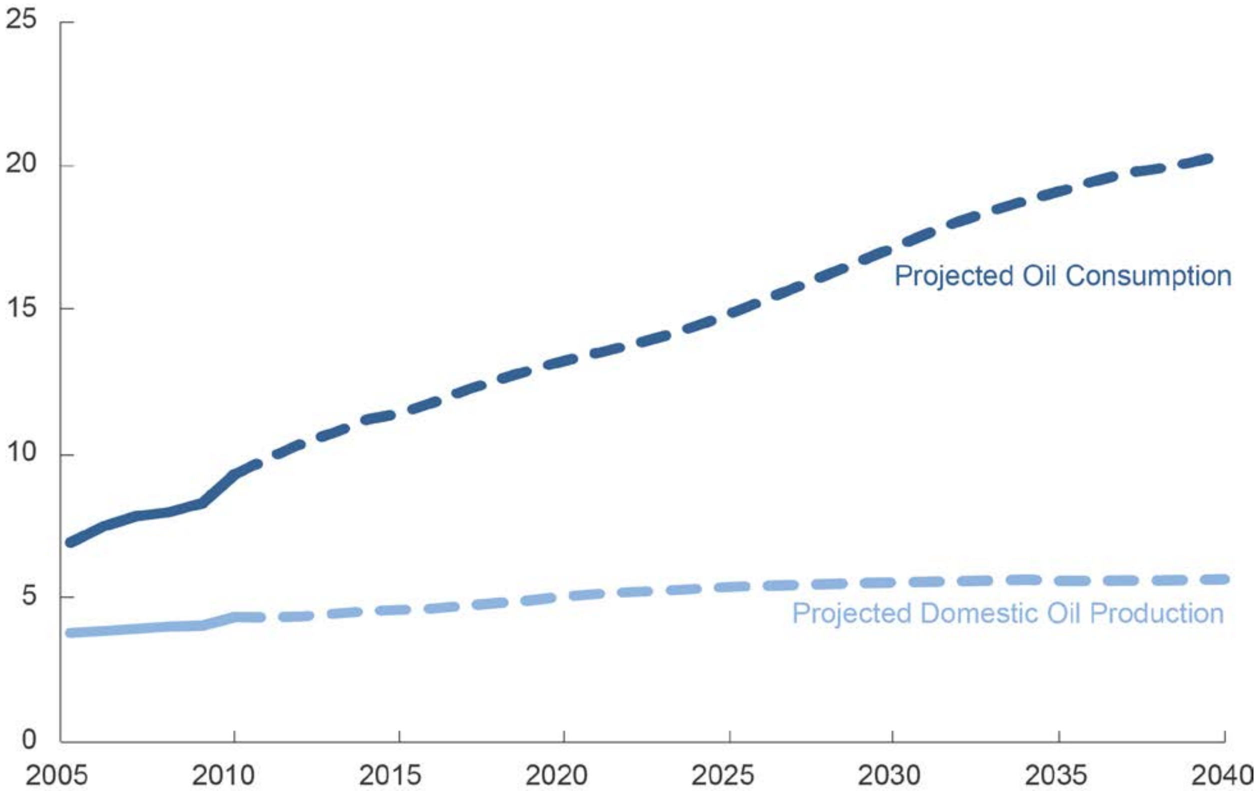
Because China's growing consumption of oil is not projected to be offset by growing production elsewhere in the world, China's demand for oil puts upward pressure on world oil prices, other things being equal. That pressure has also been observed in the past. For example, in 2013, demand for oil from both the United States and China grew by about 500,000 barrels per day, accounting for 54 percent of

[5] Reported data through 2011 are available from the World Bank, "World Development Indicators" (December 2014), Table 3.13, http://wdi.worldbank.org/table/3.13.

[6] ExxonMobil, *The Outlook for Energy: A View to 2040* (ExxonMobil Corporation, 2015), p. 19, http://tinyurl.com/mytzvnq.

Figure 5.
Actual and Projected Oil Consumption and Domestic Production in China, 2005–2040

Millions of Barrels of Oil per Day



Source: Congressional Budget Office, based on data from the Department of Energy, Energy Information Administration (www.eia.gov).

Note: Solid lines represent actual data; dashed lines indicate projected data.

new demand in the world. In that year nearly all new world production occurred in the United States, Canada, and Russia; however, that new production was less than the new demand, raising the world oil price from what it otherwise would have been.

The Chinese government has taken actions that affect the level and volatility of the price of oil. First, China has invested heavily in developing new sources of oil, most notably in Africa. By 2012, China had become the largest foreign investor in Africa and that continent's largest trading partner.[7] In 2013, China imported about a third of its oil from Africa, primarily from Angola, Sudan, South Sudan, the Republic of

[7] For more on China's investments in Africa, see Matthias Busse, Ceren Erdogan, and Henning Mühlen, *China's Impact on Africa—The Role of Trade, FDI, and Aid* (Institute of Development Research and Development Policy, 2014), http://tinyurl.com/lkqcvo8 (PDF, 2.41 MB); and Christopher Alessi and Stephanie Hanson, *Expanding China-Africa Oil Ties* (Council on Foreign Relations, February 2012), www.cfr.org/china/expanding-china-africa-oil-ties/p9557.

Congo, Equatorial Guinea, and Nigeria, but also from countries such as Gabon, Algeria, Libya, Liberia, Chad, and Kenya.[8] That additional supply, resulting from China's investment, lowered the world price of oil from what it otherwise would have been. Second, in 2004 China began building a strategic petroleum reserve to offset price increases caused by short-term oil supply outages.[9] China has set a target date of 2020 to expand total storage capacity to 500 million barrels; the U.S. strategic petroleum reserve holds 727 million barrels.[10] Filling the Chinese reserve causes the price of oil to increase for the period in which supply is diverted to storage. Using the reserve to offset supply disruptions, however, could reduce global oil price volatility to benefit all consumers of oil. Third, China imports some oil from countries on which the United States has imposed economic sanctions, such as Iran and Russia. Although such trading undermines the desired effect of the sanctions, China's purchases from Russia and Iran also tend to offset some of the increase in world oil prices that increased Chinese demand for oil would otherwise cause. In 2014, Iran was China's sixth-largest oil trading partner. And although China has pledged not to increase trade with Iran, neither has China agreed to eliminate such trade.[11]

Coal Use in China. In 2013, China was the world's largest consumer of coal, burning more coal than all other countries combined.[12] Coal meets two-thirds of China's energy needs because it is domestically abundant and can be mined inexpensively and used easily in place of other fuels. EIA expects China's coal consumption to increase at a compound annual growth rate of 1.9 percent between 2013 and 2040, driven primarily by increased demand for electricity.[13] (China uses about half its coal to generate electricity, with the other half used primarily in manufacturing, such as to produce steel, aluminum, and cement.)[14] That forecast assumes that economic growth in China remains strong over the next several

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8 Lauren Gamache, Alexander Hammer, and Lin Jones, "China's Trade and Investment Relationship With Africa," *USITC Executive Briefings on Trade* (United States International Trade Commission, April 2013), http://go.usa.gov/3DYnh (PDF, 136 KB); and Christopher Alessi and Stephanie Hanson, *Expanding China-Africa Oil Ties* (Council on Foreign Relations, February 2012), www.cfr.org/china/expanding-china-africa-oil-ties/p9557.

9 Zhang Jian, *China's Energy Security: Prospects, Challenges, and Opportunities* (Brookings Institution, July 2011); and Energy Information Administration, *China* (February 4, 2014), www.eia.gov/countries/cab.cfm?fips=CH.

10 Energy Information Administration, *China* (February 4, 2014), www.eia.gov/countries/cab.cfm?fips=CH; U.S. Department of Energy, Office of Fossil Energy, "Strategic Petroleum Reserve" (accessed February 3, 2015), http://go.usa.gov/3DYyk.

11 Energy Information Administration, *China* (February 4, 2014), www.eia.gov/countries/cab.cfm?fips=CH.

12 Energy Information Administration, *International Energy Outlook 2013* (July 2013), www.eia.gov/forecasts/archive/ieo13/.

13 EIA projects a compound annual growth rate of 2.9 percent between 2014 and 2020 with an annual growth rate declining from that of 2015. That forecast through 2020 is lower than that projected by the International Energy Agency for current law in China (3.6 percent) but higher than that projected if China follows through on all its renewable and nonfossil energy commitments (1.3 percent). Some analysts believe that growth in the use of coal could fall even lower; although significant uncertainty exists about future growth. For example, coal demand in China could increase if China increased conversion of coal to liquid fuels or to gas. For more on projected coal use in China, see Energy Information Administration, *International Energy Outlook 2013* (July 2013), www.eia.gov/forecasts/archive/ieo13/; International Energy Agency, *Medium-Term Coal Market Report 2013* (November 2013), http://tinyurl.com/pmfhjcx; and Citibank, *The Unimaginable: Peak Coal in China* (September 2013), http://tinyurl.com/qxffvcl (PDF, 837 KB).

14 Another way to characterize China's use of coal: About 85 percent of all coal burned in China is used to generate heat, called steam coal or thermal coal; the heat is converted to electricity or used in manufacturing. The remaining

decades. If growth were less than expected, or if China fully implemented policies to reduce atmospheric pollution and greenhouse gases, coal consumption could grow much less.

China imports less than 10 percent of its coal, mostly from Russia, Australia, and Indonesia. Unlike oil, coal tends to be traded regionally because it is expensive to transport; 85 percent of the world's coal is consumed in the country where it was mined.[15] Because coal markets are regional, price differences can arise and persist between coal sold in, for example, China and the United States. Over the past several years, coal prices have fallen in the United States, primarily due to increased production of natural gas, which can substitute for coal in generating electricity. Lower coal prices in the United States than in China have enabled some exports of U.S. coal to China. U.S. coal exports to China peaked in 2012 at 10 million tons (representing 8 percent of total U.S. exports and 1 percent of total U.S. consumption), but they fell to 8 million tons in 2013.[16]

Despite the predicted increase in coal consumption, EIA estimates that the share of total energy in China produced from coal will drop from 67 percent in 2014 to 63 percent by 2020 and 55 percent by 2040. That decrease reflects the Chinese government's goals to reduce coal consumption to 62 percent of total energy use by 2020 and produce 25 percent from nuclear energy, natural gas, and renewable sources.[17] Those goals are spurred by the recognition that burning coal releases large quantities of greenhouse gases and other air pollutants, such as sulfur dioxide, mercury, and precursors of smog.

Natural Gas Use in China. In 2013, natural gas satisfied only about 4 percent of China's energy demand. Improved techniques and technology to recover natural gas, many of which were developed in the United States, and the improved air quality benefits of natural gas over coal have prompted China to invest heavily in natural gas production over the past decade. Because of those efforts, EIA projects that the use of natural gas to produce electricity will increase from less than 2 percent in 2013 to about 4 percent by 2040. EIA also projects that the demand for natural gas as a source of heating will increase over the next few decades as households become wealthier and shift from traditional, dirtier heating sources such as wood and coal to modern, clean sources such as natural gas. EIA projects that between 2013 and 2040, natural gas as a share of residential energy use (which accounts for about 6 percent of China's total energy use) will increase from 17 percent to 34 percent.

China has one of the largest technically recoverable natural gas supplies in the Asia Pacific region. Yet Chinese use of natural gas is low because developing much of those reserves is not currently economically feasible. Also, the pipeline and other infrastructure necessary to bring natural gas to markets

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15 percent of coal—that with the highest energy content and fewest impurities, called metallurgical coal—is burned without oxygen and then mixed with iron to produce steel alloy.

[15] International Energy Agency, *Medium-Term Coal Market Report 2013* (IEA, November 2013), http://tinyurl.com/pmfhjcx.

[16] Energy Information Administration, "Coal Data Browser" (accessed February 24, 2015), www.eia.gov/beta/coal/data/browser/.

[17] Damien Ma, *Rebalancing China's Energy Strategy* (The Paulson Institute, January 2015), p. 13, http://tinyurl.com/psbrdw6.

in large cities is still in a nascent phase.[18] EIA expects that although China's infrastructure and capacity to bring natural gas to market will grow, the country will probably continue to import natural gas for the foreseeable future. Like coal, natural gas is expensive to transport across water and thus tends to be traded within regional markets that can be connected via pipeline. To help satisfy future demand for natural gas, China recently built natural gas pipelines and entered into long-term import contracts with Russia, Central Asian countries, and Myanmar.[19]

Natural gas can also be shipped in a pressurized form, called liquefied natural gas (LNG). LNG must be depressurized, or gasified, before it can be used. Both liquefaction and gasification are expensive processes that represent sizable investments by the importing and exporting countries. China has developed the infrastructure to become the third-largest LNG-importing country and continues to build facilities to receive LNG from major trading partners such as Australia, Indonesia, Malaysia, and Papua New Guinea. The United States has almost no trade of natural gas with countries in Southeast Asia; however, that may change over the next few years with the potential development of new LNG-exporting infrastructure in the United States.

Non-Fossil-Fuel Energy in China. China uses two types of non-fossil-fuel energy sources: nuclear energy and renewable sources, the latter including hydropower, wind, solar, geothermal, and biomass. Although nuclear energy and renewable sources accounted for about 10 percent of China's 2013 energy consumption, China invests heavily in both sources. For example, by 2020, China plans to quadruple its capacity to generate nuclear power. As a result, about half the world's new capacity globally is under construction in China. China has targeted to produce 15 percent of its energy use from nonfossil energy sources by 2020.[20] China will accomplish its renewable objectives through a mechanism described below under "Other Energy Policies in China."

Because China uses all its nuclear power and almost all its renewable energy to generate electricity, those energy sources are not often traded outside China. But as China further develops its nuclear and renewable energy, those energy sources will reduce China's growing demand for fossil fuels from regional or world markets. China is using more fossil fuel alternatives in the transportation sector by expanding capacity to produce bioethanol and biodiesel; in 2013 China became the third-largest producer of fuel ethanol, though it produces significantly less than the United States and Brazil.[21] Although domestically consumed Chinese biofuel has little effect on the U.S. biofuel market, any biofuel that reduces demand for oil will put downward pressure on the world oil price. Also, China's use of nuclear

[18] Most of China's natural gas reserves are conventional, but China is expanding exploration and production of unconventional gas resources, including coal-bed methane, tight gas, and shale gas. Geologic and logistical difficulties associated with natural gas extraction reduced current extraction quantities of unconventional resources, causing China to fall below target for unconventional gas production in 2013; see International Energy Agency, *Medium-Term Gas Market Report 2014*, http://tinyurl.com/mcqsw8e. See also Energy Information Administration, *China* (February 4, 2014), p. 21, www.eia.gov/countries/cab.cfm?fips=CH; and "Natural Gas in China: Shale Game," *Economist* (August 30, 2014), http://tinyurl.com/osxb7t7.

[19] Energy Information Administration, *China* (February 4, 2014), p. 24, www.eia.gov/countries/cab.cfm?fips=CH.

[20] Ibid., p. 34.

[21] Renewable Fuels Association, "World Fuel Ethanol Production" (2014), http://ethanolrfa.org/pages/world-fuel-ethanol-production.

and renewable energy reduces emissions from burning fossil fuels that contribute to global climate change.

Other Energy Policies in China

In addition to policies that make various energy commodities more available to Chinese households and businesses, the Chinese government pursues two types of energy policies to meet other objectives. First, the Chinese government has implemented policies to produce more renewable energy and to boost incentives to adopt energy efficiency practices. In general, relying more on renewable energy or promoting energy efficiency reduces greenhouse gas emissions in China. That policy also reduces demand for energy traded globally, which could, for example, lower global oil prices. Second, the Chinese government sets energy prices below market prices. The size of the discount from market prices is difficult to determine because some energy market prices, such as for electricity and natural gas, are largely unknown and because the Chinese government does not disclose what particular industries pay or how it establishes those prices. Those subsidies, along with other subsidies such as those provided directly to the renewable energy manufacturing sector, benefit energy-intensive manufacturing in China. At the same time, those subsidies put U.S. manufacturers at a disadvantage in international trade. In response, several renewable energy technology and energy-intensive industries in the United States—such as wind turbine manufacturers, solar panel manufacturers, and steel manufacturers—have filed and won antidumping and countervailing-duty proceedings with the U.S. Department of Commerce. Countervailing duties are tariffs that the U.S. government imposes to offset foreign subsidies to producers or exporters. (Similarly, the government can impose duties to offset dumping as a way to offset the effect of foreign firms selling goods for less than fair value.) Such subsidies serve as a remedy for the U.S. domestic market, although they do not address the competitive advantage afforded to Chinese producers in trade with other countries that have not instituted such measures.[22] (The European Commission has established countervailing duties for some goods in the renewable energy sector as well.) Subsidized energy prices also increase energy use and the associated greenhouse gas emissions.

The Chinese government can pursue those two types of policies because it controls both producer and consumer energy prices. Thus, it can increase the prices paid to producers of renewable electricity but limit what consumers pay for that electricity.

Policies That Promote Renewable Energy and Energy Efficiency. The Chinese government has formulated several goals to increase use of renewable energy and energy efficiency. China has stated that by 2020 it would like to produce 15 percent of its energy from nonfossil energy sources to reduce greenhouse gas emissions.[23] And in a recent agreement with the United States, China announced its goal

[22] For more information, see various Department of Commerce rulings available at http://enforcement.trade.gov/frn/, including the following: Utility Scale Wind Towers From the People's Republic of China: Initiation of Countervailing Duty Investigation, 77 Fed. Reg. 3447 (January 24, 2012); Crystalline Silicon Photovoltaic Cells, Whether or Not Assembled Into Modules, From the People's Republic of China: Countervailing Duty Order, 77 Fed. Reg. 73017 (December 7, 2012); and Certain Oil Country Tubular Goods From the People's Republic of China: Final Results of Countervailing Duty Administrative Review, 79 Fed. Reg. 52301 (September 3, 2014).

[23] World Bank, *World Development Report 2010: Development and Climate Change* (World Bank, 2010), http://tinyurl.com/kpsl6zx.

to produce 20 percent of its energy consumption from nonfossil energy sources by 2030.[24] China's government has also stated a more general desire to support more energy efficiency and conservation. Those policies benefit Chinese households and businesses by reducing consumption of energy commodities, such as coal and oil, that contribute to local air pollution and climate change. Those policies may also benefit U.S. consumers by reducing demand for globally traded energy commodities, such as oil, which may reduce upward pressure on prices. To reach those goals, the Chinese government has used a combination of long-term planning, legislation, and financial incentives. The last three planning documents that the Chinese government used to guide economic growth, called Five-Year Plans, have incorporated large non-fossil-fuel energy targets.

The primary policy supporting increased use of nonfossil fuels in China was the Renewable Energy Law of 2005, which levied a fee on all electricity use and allocated those funds to develop new renewable energy projects. China amended the law in 2009 to require grid operators to purchase all the electricity produced from renewable sources. That same year, China also doubled the fee on electricity usage charged to the industrial sector. The revenue from the law was distributed through additional programs that used feed-in tariffs and subsidies. (Feed-in tariffs are paid as a subsidy to renewable energy generators in an amount that represents the incremental cost of production above the market price for electricity.) For example, a feed-in tariff of $0.16 per kilowatt-hour was paid to generators of solar electricity in 2009.[25] That was in addition to a subsidy of $3,000 per kilowatt for large solar installations, an amount that could cover more than half the system's total cost. Other subsidies and support include low-interest financing options for renewable projects, subsidies to farmers for each acre used to produce biofuels, and a production subsidy for each ton of biomass pellets used.

Because of those actions, energy generated from renewable sources grew dramatically between 2005 and 2013 and is expected to grow further by 2020. In 2013, China became the world's largest producer of hydroelectric energy with more than 229 gigawatts (GW) of installed capacity, nearly double the 2005 capacity. (China's largest hydroelectric facility, called Three Gorges Dam, was completed in 2012 and represents 22.5 GW of installed capacity.) China was also the largest generator of wind power in 2013, with 91 GW of installed capacity—a 72-fold increase from 2005.[26] China was second to Germany in solar power in 2013, with 19 GW of installed solar capacity. Between 2013 and 2020, China plans to increase hydroelectric capacity by two-thirds and to more than double wind and solar capacity.[27] To meet energy needs in rural areas, the use of biomass has grown from 2 GW in 2005 to 13 GW in 2013, with plans to

[24] The White House, "U.S.-China Joint Announcement on Climate Change" (press release, November 12, 2014), http://go.usa.gov/3DYsP.

[25] Richard J. Campbell, *China and the United States—A Comparison of Green Energy Programs and Policies*, Report for Congress R41748 (Congressional Research Service, April 30, 2014).

[26] In contrast, wind power in the United States increased from 9 GW of installed capacity in 2005 to 61 GW in 2013. American Wind Energy Association, *U.S. Wind Industry Fourth Quarter 2013 Market Report* (January 30, 2014), www.awea.org/4Q2013.

[27] Richard J. Campbell, *China and the United States—A Comparison of Green Energy Programs and Policies*, Report for Congress R41748 (Congressional Research Service, April 30, 2014).

increase to 30 GW by 2020.[28] In substitutes for transportation fuel, China is also increasing its capacity to produce bioethanol and biodiesel, as stated earlier.

In the Energy Conservation Law of 1997, the Chinese government established energy efficiency as a national priority: The "state shall encourage and support research and popularization in the science and technology of energy conservation." Energy efficiency programs are designed to reduce demand for other traded energy commodities, such as coal, natural gas, and oil, and reduce the energy required to maintain manufacturing output at given levels. The energy consumption per unit of Chinese gross domestic product (GDP), or energy intensity, fell by about 10 percent between 2006 and 2008. That decrease saved the equivalent of 290 million tons of coal. Energy intensity is expected to fall another 16 percent between 2010 and 2015.[29]

Energy Pricing Policy. To reduce consumer price inflation while increasing incentives to develop domestic energy sources, the Chinese government controls energy prices across the economy. For businesses in China, the price controls subsidize the use of electricity, natural gas, or transportation fuels, ultimately lowering production costs.[30] Because they must buy energy at market prices but then sell it at the controlled, lower price, electricity generators, natural gas importers, and refineries have often incurred large losses. As a result, they often reduce production or idle their capacity when market prices for inputs are high. Recently, the Chinese government has taken steps to reduce the effect of some price controls, although China will probably not eliminate the subsidies in the near future.

Gasoline and diesel markets have experienced the most significant reforms for price controls. The Pricing Bureau of the National Development and Reform Commission (NDRC) historically set price controls to subsidize gasoline and diesel for consumers. At the same time, nationally owned refiners in China were forced to buy oil at the global price and sell at the lower, controlled price. Consequently, they had an incentive to either reduce their output or export their finished product abroad, creating shortages within China; the largest national refiners posted losses for most of the 2007–2012 period.[31] To harmonize domestic refined product prices with global market prices in 2009, the NDRC adopted a policy to adjust the retail price of diesel and gasoline when the moving-average price of imported crude oil fluctuated from the government-imposed price by more than 4 percent. But the commission abandoned the policy after reports that people hoarded diesel and gasoline fuels in the days before the first adjustment. Starting

[28] Jonathan Moch, *Renewable Energy in China: An Overview* (World Resources Institute, July 2013), http://tinyurl.com/q3ky8nt.

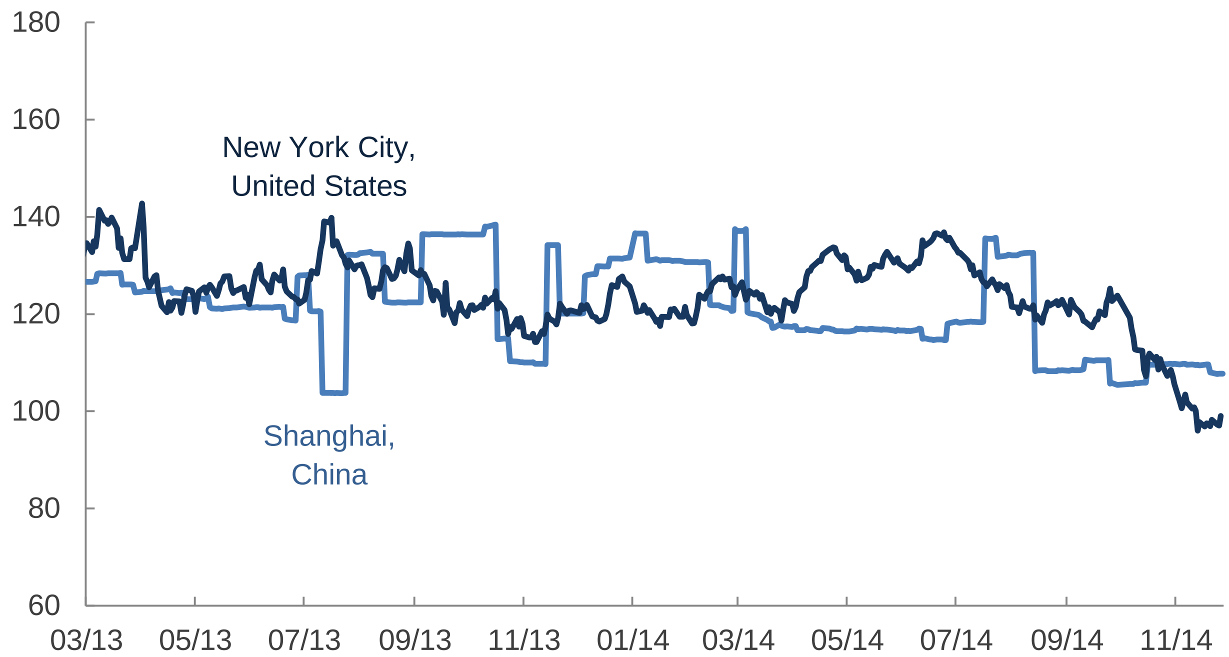
[29] Such a reduction in energy intensity would be a significant accomplishment. For more information on energy intensity reductions between 2005 and 2010, see Lisa Mastny, ed., *Renewable Energy and Energy Efficiency in China: Current Status and Prospects for 2020* (Worldwatch Institute, October 2010), http://tinyurl.com/pmzotq6. For more on reductions between 2010 and 2015, see Stian Reklev and Kathy Chen, "China Cuts Energy Intensity by 4.8 Pct in 2014," *Reuters* (January 19, 2015), http://tinyurl.com/mmm48tr.

[30] Ryan Rutkowski, "Rebalancing and Rising Electricity Prices in China," *China Economic Watch*, Peterson Institute for International Economics (blog entry, February 18, 2014), http://blogs.piie.com/china/?p=3760; and "China Price Reform Update—1H2014," *China Economic Watch*, Peterson Institute for International Economics (blog entry, August 6, 2014), http://blogs.piie.com/china/?p=4003.

[31] Ryan Rutkowski, "China Price Reform Update—1H2014," *China Economic Watch*, Peterson Institute for International Economics (blog entry, August 6, 2014), http://blogs.piie.com/china/?p=4003.

Figure 6.
Price of Gasoline in New York City and Shanghai, March 2013–November 2014

United States Dollars per Barrel of Gasoline



Source: Congressional Budget Office, based on data from the Peterson Institute for International Economics.

Note: Some volatility in the Shanghai price is due to fluctuations in the value of the yuan in relation to that of the U.S. dollar. Over the period analyzed, the Chinese government issued 29 changes to the posted price of gasoline in Shanghai (and elsewhere in China).

in March 2013, the NDRC simplified the approach to adjust retail gasoline prices when a discrepancy of more than a threshold amount occurred between the government-imposed price and running-average market price (see Figure 6).[32] However, the NDRC still limits the price of a barrel of oil to $130. The price of oil fluctuated within a fairly narrow range between March 2013 and June 2014 but has fallen since then. Between March 2013 and December 2014, the NDRC approved 29 price changes, which suggests that the Chinese price is similar to the world price but rarely the same.[33] The current policy has not yet been tested in an environment with rising oil prices.

[32] Energy Information Administration, *China* (February 4, 2014), www.eia.gov/countries/cab.cfm?fips=CH.

[33] For more on price controls in China, see Damien Ma, "China's Search for a New Energy Strategy," *Foreign Affairs* (June 4, 2013), http://tinyurl.com/n4g5cwz; Energy Information Administration, *China* (February 4, 2014), www.eia.gov/countries/cab.cfm?fips=CH; and Ryan Rutkowski, "The Price of Power: The New Chinese Leadership Begins Rebalancing With Resource Prices," *China Economic Watch*, Peterson Institute for International Economics (blog entry, July 16, 2014), http://blogs.piie.com/china/?p=2913.

In the market for coal and electricity, reforms to eliminate energy subsidies to industry have been much less effective. Before 2012, the NDRC set a low contracted coal price for electricity generators and a low retail electricity price for households and businesses. When coal prices on the spot market (where transactions are settled at current market prices rather than at contracted rates) rose above the low contracted price, coal mines would choose to sell into the spot market and not deliver coal under the terms of their low-priced contract with electricity generators. During those periods, electricity generators were forced to purchase higher-priced coal from the spot market, which sometimes included U.S. producers, despite having a low fixed price they earned for delivering electricity to households and businesses.[34] In 2011, spot prices for coal were higher than the contracted rate between mines and electricity generators, raising the cost of coal for generators. Instead of incurring large losses, many generators idled units or reduced output, creating widespread blackouts.[35] Still, the five largest coal-based electricity producers lost more than $2 billion in that year.[36] Recognizing the difficulties of such a system, the NDRC in 2012 began allowing utilities to negotiate prices directly with coal mines and allowing utilities to pass some cost increases on to some retail electricity rates. Industrial uses of electricity, however, remain largely subsidized through below-market rates.[37]

The NDRC uses price controls to encourage domestic production and consumption of natural gas. In 2010, the NDRC increased the price paid to producers of natural gas by 25 percent and, at times, linked natural gas prices to the higher price of imported oil. To encourage consumption, the NDRC then discounted those higher prices for consumers of natural gas.[38] Below-market natural gas prices served as a subsidy for industrial end users of natural gas. The combination of higher raw material prices and lower end-user prices, however, caused natural gas processers and importers to incur losses. In June 2013, the price of natural gas was raised for industrial users by 15.4 percent, and in March 2014, the NDRC allowed prices to rise for residential end users. Those higher prices are still believed to be below the market price for natural gas.[39]

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[34] International Energy Agency, *The Impact of Global Coal Supply on Worldwide Electricity Prices: Overview and Comparison Between Europe, the United States, Australia, Japan, China, and South Africa* (IEA, 2014), p. 48, http://tinyurl.com/o9ug9zc.

[35] Chris Leung, "China: A Case Study of Price Control on Electricity" (DBS Group Research, May 20, 2011), http://tinyurl.com/p8zl8ge.

[36] Ryan Rutkowski, "China Price Reform Update—1H2014," *China Economic Watch*, Peterson Institute for International Economics (blog entry, August 6, 2014), http://blogs.piie.com/china/?p=4003.

[37] Ryan Rutkowski, "The Price of Power: The New Chinese Leadership Begins Rebalancing With Resource Prices," *China Economic Watch*, Peterson Institute for International Economics (blog entry, July 16, 2014), http://blogs.piie.com/china/?p=2913. In 2013, the NDRC did relax price controls for aluminum manufacturing, the third-largest consumer of electricity after steel and chemical production. For more, see Ryan Rutkowski, "Rebalancing and Rising Electricity Prices in China," *China Economic Watch*, Peterson Institute for International Economics (blog entry, February 18, 2014) , http://blogs.piie.com/china/?p=3760.

[38] Ryan Rutkowski, "The Price of Power: The New Chinese Leadership Begins Rebalancing With Resource Prices," *China Economic Watch*, Peterson Institute for International Economics (blog entry, July 16, 2014), http://blogs.piie.com/china/?p=2913.

[39] Ryan Rutkowski, "China Price Reform Update—1H2014," *China Economic Watch*, Peterson Institute for International Economics (blog entry, August 6, 2014), http://blogs.piie.com/china/?p=4003; and Ting Wang and Boqiang Lin, "China's Natural Gas Consumption and Subsidies—From a Sector Perspective," *Energy Policy*, vol.

Such price controls also have other unintended consequences. Energy prices below the prevailing market price create an incentive for households and businesses to consume more energy in the short term. And the expectation that energy prices will be held down over the long term encourages those consumers to invest in energy-intensive capital or technologies that are not energy efficient and increase emissions of local pollutants and greenhouse gases. The largest consumers of energy in China are heavy industries such as steel and aluminum, which collectively consume three-quarters of China's energy. For those firms, below-market prices for electricity, natural gas, and fuel reduce production cost and make their exports more competitive on the world market.

III. Implications of China's Energy Growth and Policies for U.S. Households and Businesses

China's energy use and policies affect U.S. households and businesses through several channels. First, when China and the United States purchase energy from the same market, as with oil, increased Chinese demand will increase prices and possibly price volatility for U.S. energy users. Second, direct renewable energy subsidies and energy price controls for Chinese firms, combined with other subsidies unrelated to energy, lower manufacturing costs. As a result, China's exports become more attractive in international markets, whereas U.S. exports become less attractive. Conversely, subsidies that lead to technological innovations or the deployment and diffusion of renewable technologies could spill over to benefit equivalent industries in the United States and lower emissions of greenhouse gases from what they would have been without such innovations. Third, increased demand for energy, particularly fossil fuels, will increase emissions that contribute to global climate change.

Energy policy in China also affects U.S. foreign policy, although a full analysis is beyond the scope of this paper. For example, China has not fully supported U.S. sanctions against Iran and imported substantial amounts of Iran's oil. In 1996 the U.S. government enacted sanctions against any company that invested more than $20 million in petroleum resources in Iran. The U.S. government strengthened and extended sanctions against Iran in 2010. Such embargoes work best in achieving foreign policy objectives when all countries adhere to the sanctions. Without such adherence, oil or money from the embargoed countries simply flows through countries that do not adhere and little overall change occurs (beyond some transaction costs for the embargoed countries to develop new trading partners). But world adherence to, for example, an oil embargo of Iran would probably raise the world price of oil substantially because Iranian oil could no longer reach the world market. Such embargoes have not affected price much because not all countries participate. In 2014, Iran was the sixth-largest exporter of oil to China. China recently agreed to not increase imports from Iran but would not eliminate them: Iran's oil can still reach the market, leaving world oil prices mostly unaffected, though the embargo then has less effect on the Iranian government.[40]

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65 (February 2014), pp. 541–551, http://dx.doi.org/doi:10.1016/j.enpol.2013.10.065. The second article suggests that natural gas prices in 2004 were more than 50 percent below comparable market prices.

[40] Similarly, in response to Russia's actions in Ukraine in 2014, the U.S. government restricted technology transfer and trade with Russian oil firms. Although China's full response to those sanctions has yet to be observed, Russia has sought ways to diversify its trading partners, increasingly turning to China. For example, in May 2014, Russia

Energy Market Price and Volatility

China imports three primary energy commodities: oil, coal, and natural gas. Because the oil market is globally integrated, increased demand for imported oil from China affects U.S. consumers through higher oil prices and possibly increased volatility. The markets for coal and natural gas are much less globally integrated, with changes in China's demand affecting U.S. consumers very little. Specifically, increased demand for oil from China that increased production elsewhere does not offset would raise the world oil price and prices of refined oil products. Moreover, additional instability in the world oil market may increase oil price volatility—causing unexpected and temporary changes in energy prices. Because price volatility makes future prices uncertain, it tends to be costly for U.S. households and businesses, complicating investment decisions. A large, sudden spike in energy prices could have a short-term influence on consumer spending by affecting consumer confidence. People might postpone some purchases out of concern about how the disruption would affect the economy. Those reductions in demand would tend to lead businesses to temporarily reduce investment and employment, thereby diminishing household income and further lowering consumer spending.

Oil Price Levels. Between 2008 and 2013 the world price of oil rose because demand exceeded supply and was expected to grow faster than supply in the future. Growing demand from China contributed to rising oil prices. In the United States, higher oil prices affect U.S. households and businesses both directly and indirectly. For direct costs, consumers would have to pay more for the refined oil products used in transportation and for other goods and services produced with oil. Some of that increased spending is paid to foreign producers or owners of oil assets and does not immediately translate into increased demand for U.S. exports, depressing U.S. economic growth. For indirect costs, those higher prices would reduce consumption of other goods and services. Taken together, the direct and indirect effects of higher oil prices dampen GDP from what GDP would otherwise have been.

Other policies in China, such as subsidies that hold down the price of oil or increase use of oil substitutes, have probably had small effects. China's price controls for gasoline and diesel probably helped to increase consumption of those fuels and raise oil prices, although the effects of such price controls appear to have diminished greatly. Conversely, subsidies for alternative petroleum-based transportation, including those for bioethanol, biodiesel, and high-speed rail, probably reduced China's demand from the world oil market and reduced the upward pressure on the price of oil for U.S. consumers.

Oil Price Volatility. Volatility of oil prices in the world market is determined by the stability of oil-producing countries and those countries' ability to increase or decrease production in response to changing prices. Consumers' ability to reduce consumption when prices rise can also affect volatility. Oil-producing countries have little spare capacity to produce more oil quickly when prices rise. And, at least in the short term, consumers have few substitutes for oil and its refined products, which means that volatility is determined primarily by the stability of supply. The increased world demand for oil, including that from China, puts upward pressure on the price of oil, which encourages countries and firms to bring new sources of supply to the market. Over the past decade, much of the new supply came from countries considered more stable—the United States and Canada—reducing volatility in the oil market. When

made a long-term agreement to sell gas to China. Such partnerships would make U.S. and European sanctions less effective.

additional supply comes from countries that are less stable because of domestic or regional unrest, insufficient infrastructure, or technically complicated oil fields, volatility in the oil market would be expected to rise.[41]

Since 2000, China has invested heavily in developing oil fields throughout Africa, including Nigeria, Angola, Chad, Niger, and South Sudan.[42] New supply from those countries and others in Africa entered the market and satisfied about a third of China's oil demand. Those countries and their supply, however, tend to be less stable than U.S. or Canadian oil supplies. For example, in 2013, Nigerian oil production fell by almost 450,000 barrels of oil per day to a four-year low as a result of vandalism, kidnappings, and militant takeovers.[43] Similarly, in 2012, Sudan and South Sudan could not agree on how to share oil revenues; both countries reduced production by about 300,000 barrels of oil per day.[44] Those two events, among other unplanned disruptions, raised the world oil price. It remained elevated until the supply from Nigeria and South Sudan returned to the market and was believed to be stable.

Lack of transparency within the Chinese economy about oil consumption, a second source of price volatility, reduces oil analysts' ability to predict demand trends.[45] To address that concern, the U.S. Department of Energy recently agreed to help China develop an energy data agency similar to the U.S. Energy Information Administration.[46] Consider one example of the challenge associated with lack of transparency: In 2004, electricity generators refused to sell electricity at the government-imposed price because the cost to generate the power was higher. The generators chose to shut down, causing blackouts throughout China and a spike in the diesel and fuel oil that Chinese companies purchased to power backup electricity generators. Data describing the domestic inventories of refined products were not readily available for analysts to understand whether businesses were purchasing more oil than needed for current consumption. Without inventory data, oil consumption in China appeared to increase by 16 percent between 2003 and 2004, compared with 11 percent in the previous year. The market, assuming that increase in demand was permanent, responded by dramatically increasing the price of oil. In response to higher prices, refining capacity increased. But because of draw-down of oil inventories, new coal-fired power capacity in China, and fewer blackouts in 2005, the expected increased demand did not occur. Oil prices then fell.

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[41] To explore how political instability contributes to market volatility, see James Hamilton, "Historical Oil Shocks," in Randall E. Parker and Robert Whaples, eds., *Routledge Handbook of Major Events in Economic History* (Routledge, Taylor and Francis Group, 2013), pp. 239–265, www.routledge.com/books/details/9780415677035/.

[42] Lauren Gamache, Alexander Hammer, and Lin Jones, "China's Trade and Investment Relationship With Africa," *USITC Executive Briefings on Trade* (United States International Trade Commission, April 2013), http://go.usa.gov/3DYnh (PDF, 136 KB).

[43] See Energy Information Administration, *Nigeria* (December 30, 2013), www.eia.gov/countries/cab.cfm?fips=NI; and Energy Information Administration, "Global Crude Oil Supply Disruptions and Strong Demand Support High Oil Prices," *Today in Energy* (September 10, 2013), www.eia.gov/todayinenergy/detail.cfm?id=12891.

[44] Energy Information Administration, *Sudan and South Sudan* (September 3, 2014), www.eia.gov/countries/cab.cfm?fips=SU.

[45] Daniel H. Rosen and Trevor Houser, *China Energy: A Guide for the Perplexed* (Peterson Institute for International Economics, May 2007), pp. 28–29, www.piie.com/publications/papers/rosen0507.pdf (2.5 MB).

[46] Michael Barris, "U.S. Energy Chief Welcomes China's Transparency on Data," *China Daily USA* (December 13, 2013), http://tinyurl.com/n4ktknn.

Coal Price Levels and Volatility. Though relatively low, Chinese demand for U.S.-produced coal has put upward pressure on U.S. coal prices, but that effect has probably been small. Similarly, increases in China's demand for coal would probably not make coal prices more volatile for U.S. consumers. China's increased demand for coal probably represents a net benefit for U.S. coal producers. The United States is a net exporter of coal, with about 8 million short tons exported to China in 2013. Some Chinese generators buy U.S. coal because the spot price of coal in China has sometimes been higher than the cost of importing coal from the United States. Although exports of coal to China have put some upward pressure on U.S. coal prices, U.S. producers of coal exported only 0.8 percent of total production to China in 2013. (The United States exported about 10 percent of the coal it produced, mostly to the United Kingdom and the Netherlands.)47 Because a variety of fuels are used to generate electricity, coal exports to China probably do not appreciably affect U.S. electricity prices. Moreover, between Environmental Protection Agency regulations announced in 2013 and aging coal-fired power plants, the amount of coal-generated electricity in the United States will probably fall further over the next decade. Upward pressure on coal prices benefits the owners and employees of coal assets and probably keeps some coal mines operating longer than they would without trade with China.

Natural Gas Price Levels and Volatility. Changes in China's consumption of natural gas will probably not increase prices or affect price volatility for U.S. consumers. The United States is expected to be a net exporter of natural gas in the near term, although it will probably still import some natural gas from Mexico and Canada through existing pipelines. The United States has the world's lowest natural gas prices: In January 2015 natural gas traded for about $3 per thousand cubic feet in the United States, about $9 in Europe, and $14 in Japan and China. The cost to liquefy and ship LNG overseas is less than that price difference, and thus U.S. firms are building LNG facilities to ship natural gas abroad. EIA expects that even the most optimistic projections of LNG exports will have little or no effect on U.S. natural gas prices because they represent such a small percentage of U.S. supply.[48] However, owners and employees of businesses that produce and liquefy natural gas would be expected to earn increased profits from selling LNG abroad, regardless of who purchases it.

Competitiveness in Manufacturing

China's policies to subsidize renewable technologies and control energy prices for Chinese businesses probably make U.S. firms that manufacture renewable technologies or energy-intensive products less competitive. How much those two subsidies affect the United States is difficult to determine. And price controls will probably affect energy prices less than other Chinese policies that may affect U.S. firms such as currency devaluation, indigenous content requirements, preferential tax and export promotion policies, and low-interest loans or reduced prices for land or technology).[49] Yet those energy subsidies make goods

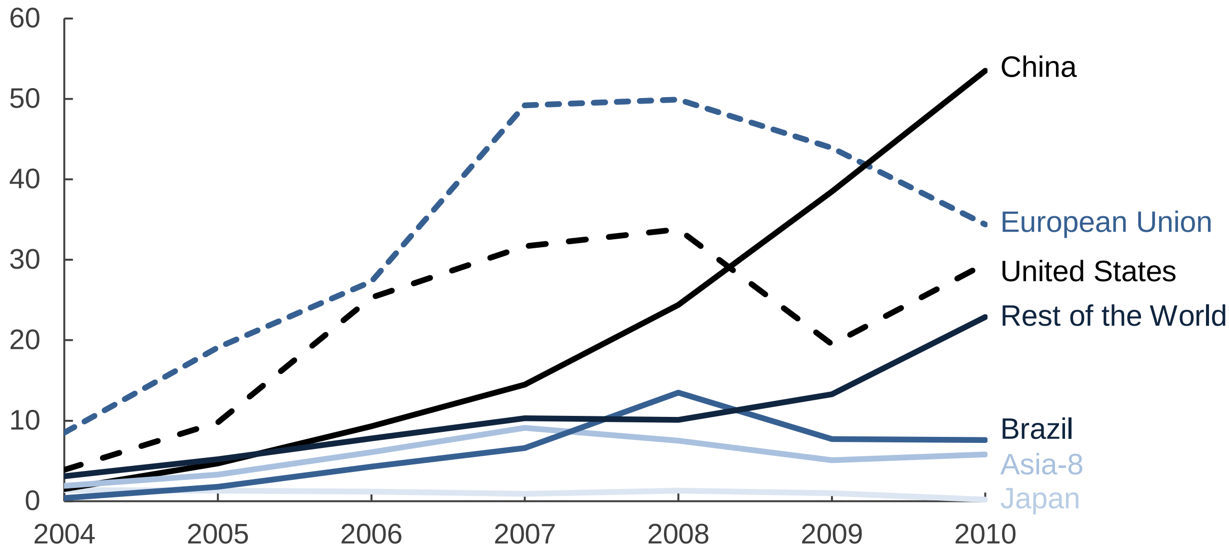
[47] Energy Information Administration, "Coal Data Browser," (accessed February 24, 2015), www.eia.gov/beta/coal/data/browser/.

[48] Energy Information Administration, *Annual Energy Outlook 2014* (April 2014), www.eia.gov/forecasts/aeo/.

[49] Indigenous content requirements mandate that a particular share of technologies sold in China be produced in China, which may require foreign firms wanting to sell inside China to locate R&D facilities there. Such policy lets Chinese firms more easily capture intellectual property. For more, see Matthew Stepp and Robert D. Atkinson, *Green Mercantilism: Threat to the Clean Energy Economy* (Information Technology and Innovation Foundation,

Figure 7.
Financial New Investment in Clean Energy and Technologies, 2004–2010

Billions of Nominal United States Dollars



Source: Congressional Budget Office, based on investment data from the National Science Board, Science and Engineering Indicators 2012.

Notes: Asia-8 includes India, Indonesia, Malaysia, Philippines, Singapore, South Korea, Taiwan, and Thailand. Clean energy and technologies include biomass, geothermal, wind, solar, biofuels, smart grid, and energy efficiency.

and services imported from China cheaper for U.S. consumers. Also, Chinese subsidies that promote innovation in the deployment and diffusion of renewable technologies help reduce greenhouse gas emissions in China and other countries and could also increase the use of those technologies in the United States.

Reduced U.S. Competitiveness. The Chinese government subsidizes the development of renewable technologies, most notably solar, wind, and biofuel capacity. For the first time in 2010, China invested more in renewable energy and energy efficiency than any other country (see Figure 7). Subsidies to renewable technologies occur directly through feed-in tariffs and direct payments and occur indirectly through below-market rates for electricity—a significant input for solar panel and wind turbine manufacturing. Both types of subsidies have enabled Chinese renewable manufacturing companies to rapidly build economies of scale and bring their costs below those of many U.S. renewable manufacturing companies. Unable to compete with low Chinese prices, several large U.S. solar manufacturers declared

June 2012), http://tinyurl.com/74mgq5e. For a more complete discussion of subsidies in China, including energy subsidies, see Usha C.V. Haley and George T. Haley, *Subsidies to Chinese Industry: State Capitalism, Business Strategy, and Trade Policy* (Oxford University Press, 2013), http://tinyurl.com/lrjm669; and Usha C.V. Haley and Douglas A. Schuler, "Government Policy and Firm Strategy in the Solar Photovoltaic Industry," *California Management Review*, vol. 54, no. 1 (Fall 2011), pp. 17–38, http://dx.doi.org/10.1525/cmr.2011.54.1.17.

bankruptcy. The U.S. Department of Commerce hears claims from U.S. businesses about unfair trade practices in other countries. It recently ruled that several Chinese subsidies of renewable technologies are unfair and justify establishing countervailing duties.[50] Such duties could make U.S. products more competitive in domestic markets but would not help U.S. manufacturers sell their products to countries other than the United States or China because such duties would not apply to Chinese products sold in those countries.

The Chinese government also indirectly subsidizes energy-intensive manufacturing by controlling energy prices, most notably for electricity and natural gas. Those price controls, among other subsidies unrelated to energy, lower the cost for manufacturers to bring to market products and services that rely on electricity or natural gas. That arrangement benefits mainly manufacturing sectors in China that use substantial electricity and have large exports; in the United States, those sectors are chemicals; primary metals, such as aluminum and steel; automobiles and trucks; and consumer and electronic products, including solar technologies (see Figure 8). Because energy prices were not controlled to the same extent in the United States, China's energy subsidy reduced the relative competitiveness of U.S. goods and services in those sectors on the international and domestic markets.

Estimating the size of subsidies resulting from price controls is difficult. Price control subsidies probably represent a small share of all the subsidies the manufacturing sector receives, making price controls less important.[51] In one estimate of the magnitude of the subsidies, the Chinese government reports that return on assets in the electricity sector in 2014 was 3.9 percent, compared with a competitive low-risk prime lending rate of 5.8 percent. That comparison suggests that even with recent reforms, electricity prices for end users are still below what electric utilities would charge to be earning the competitive low-risk rate on their assets.[52] In a second estimate of the size of energy subsidies, the industrial price for natural gas in 2013 increased by 15.4 percent, which still left the controlled price below the market price. Although the

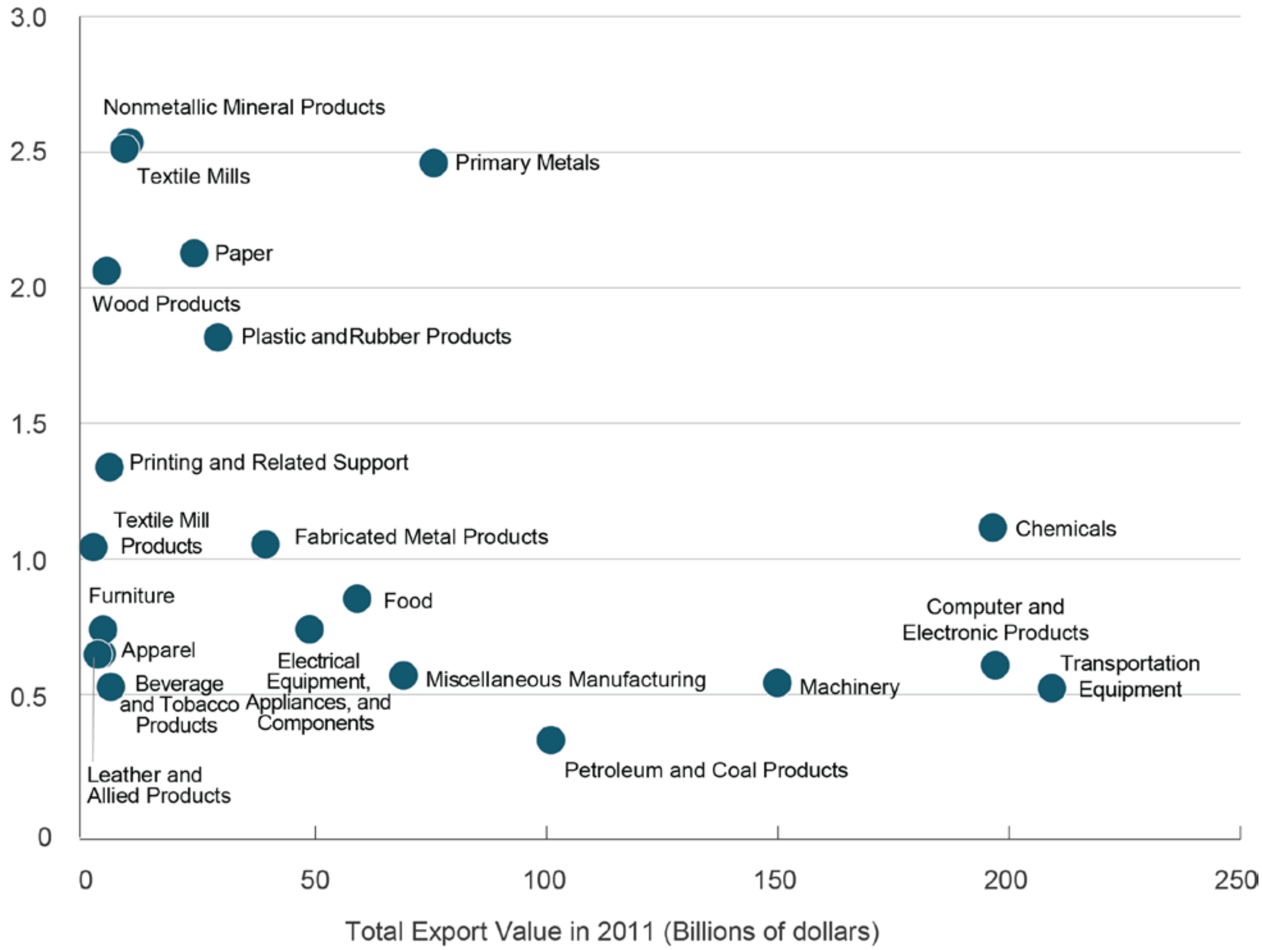
[50] For more information, see various Department of Commerce rulings available at http://enforcement.trade.gov/frn/, including the following: Utility Scale Wind Towers From the People's Republic of China: Initiation of Countervailing Duty Investigation, 77 Fed. Reg. 3447 (January 24, 2012); Crystalline Silicon Photovoltaic Cells, Whether or Not Assembled Into Modules, From the People's Republic of China: Countervailing Duty Order, 77 Fed. Reg. 73017 (December 7, 2012); and Certain Oil Country Tubular Goods From the People's Republic of China: Final Results of Countervailing Duty Administrative Review, 79 Fed. Reg. 52301 (September 3, 2014).

[51] Some analysts suggest that other subsidies for heavy industry, such as those for land or financing, represent a larger set of subsidies. See Daniel H. Rosen and Trevor Houser, *China Energy: A Guide for the Perplexed* (Peterson Institute for International Economics, May 2007), www.piie.com/publications/papers/rosen0507.pdf (2.5 MB). Multiple industry complaints and government analyses, however, suggest that energy price controls create a competitive advantage for Chinese manufacturing. For example, see Usha C.V. Haley, *Putting the Pedal to the Metal: Subsidies to China's Auto-Parts Industry from 2001 to 2011* (Economic Policy Institute, January 31, 2012), www.epi.org/publication/bp316-china-auto-parts-industry/; Kevin M. Dempsey, American Iron and Steel Institute, letter to Douglas M. Bell, Chair, Trade Policy Staff Committee, Office of the U.S. Trade Representative (September 17, 2014), http://tinyurl.com/o7z63sw; and Christian Marsh, Deputy Assistant Secretary for Antidumping and Countervailing Duty Operations, memo to Paul Piquado, Assistant Secretary for Import Administration, U.S. Department of Commerce (February 1, 2013), http://go.usa.gov/3DgqA (PDF, 401 KB).

[52] Ryan Rutkowski, "China Price Reform Update—1H2014," *China Economic Watch*, Peterson Institute for International Economics (blog entry, August 6, 2014), http://blogs.piie.com/china/?p=4003.

Figure 8.
Electricity Intensity of U.S. Exports by Export Value and Industry, 2011

Electricity Intensity Share (Dollars of purchased electricity / finished value × 100 percent)



Source: Congressional Budget Office, based on data from the U.S. Census and U.S. Department of Commerce International Trade Administration.

Chinese government recently tried to reduce some of its price controls, it probably did not intend those changes to eliminate energy subsidies for industrial end users.

Benefits for U.S. Consumers. Although some Chinese subsidies may hurt some U.S. households and businesses through lost jobs or lower sales, those same subsidies may enable other U.S. households and businesses to pay less for goods and services. For example, the cost of solar installations has fallen significantly over the past decade, driven largely by low-cost Chinese solar imports.[53] By some estimates, U.S. consumers have saved more than $500 billion between 2001 and 2010 because of lower-priced

[53] Eric Roston, "Solar Silicon Price Drop Brings Renewable Power Closer" (*Bloomberg News*, March 13, 2012), http://tinyurl.com/lcge9fn.

Chinese imports of such items as solar panels and children's toys.[54] Although the full price difference between U.S.-made and Chinese-made goods and services depends on many factors, energy subsidies in China contribute to the difference, particularly for goods and services that are energy intensive to produce. In general, the benefits to U.S. consumers from foreign subsidies outweigh the harm to U.S. manufacturers from lost competitiveness unless the subsidies reduce competition.[55] In this instance, Chinese subsidies may have reduced competition; some U.S. producers cited Chinese subsidies as having contributed to their bankruptcy. The reduced competition would tend to result in higher prices that would offset the benefit of the subsidy to consumers so that the net effect is unknown.

By supporting innovation that can be transferred outside China, Chinese energy subsidies can also help U.S. consumers. Even so, the anticompetitive effects of Chinese energy subsidies may outweigh such benefit. Chinese firms are probably not engaged in basic research that will benefit U.S. firms, but Chinese innovations in deploying and diffusing renewable energy technologies could benefit some U.S. companies.[56] For example, some Chinese companies are experimenting with using ultra-high-voltage transmission and smart-grid technology to better manage the storage and transmission of electricity generated through renewable technologies. Innovations in those technologies would benefit many countries.[57] The literature includes some debate about the extent to which innovations exist that can be transferred to other countries, as evidenced by Chinese companies tending to have fewer patents than counterparts elsewhere in the world.[58] But for innovation in deployment and diffusion that is transferrable, multinational manufacturers with facilities in China or other types of knowledge-sharing partnerships may serve as a mechanism to disseminate Chinese-subsidized innovation to benefit all buyers of renewable technology.

Climate Change

Stabilizing the concentration of greenhouse gases in the atmosphere will be virtually impossible if China—and other countries with rapidly growing economies, such as India, Brazil, and South Korea—do not substantially cut their emissions.[59] Until about eight years ago, the United States had more global

[54] Both the Chinese government and independent economic analyses state the magnitude of savings to U.S. consumers. See "Hu's Counting: Has China Saved U.S. Consumers $600 Billion, as Hu Jintao Claims?" *Economist* (blog entry, January 28, 2011), http://tinyurl.com/4uey3f5; this blog cites Raphael Auer and Andreas M. Fischer, "The Effect of Low-Wage Import Competition on U.S. Inflationary Pressure," *Journal of Monetary Economics*, vol. 57, no. 4 (May 2010), pp. 491–503, http://dx.doi.org/10.1016/j.jmoneco.2010.02.007.

[55] See, for example, Steven M. Suranovic, "Welfare Effects of an Export Subsidy: Large Country" (last updated August 20, 2004), http://internationalecon.com/Trade/Tch90/T90-27.php.

[56] Usha C.V. Haley and George T. Haley, *Subsidies to Chinese Industry: State Capitalism, Business Strategy, and Trade Policy* (Oxford University Press, 2013), http://tinyurl.com/lrjm669.

[57] Liu Zhenya, "Ultra-High-Voltage Transmission Can Break China's Cycle of Energy Dependence," *Forbes* (September 18, 2014), http://tinyurl.com/ns8d59x.

[58] See Long Lam, Lee Branstetter, and Inês L. Azevedo, *Too Fast, Too Soon? The Rise of the Chinese Wind Turbine Manufacturing Industry*, Center for Climate and Energy Decision Making Working Paper (Center for Climate and Energy Decision Making, June 20, 2014), http://tinyurl.com/lvlq5x6 (PDF, 1.2 MB).

[59] Sheila M. Olmstead and Robert N. Stavins, "Three Key Elements of a Post-2012 International Climate Policy Architecture," *Review of Environmental Economics and Policy*, vol. 6, no. 1 (Winter 2012), pp. 65–85, http://dx.doi.org/10.1093/reep/rer018.

emissions than any other single country, but China is now the single largest emitter. China accounts for roughly 25 percent of global emissions (with the United States accounting for 15 percent), and China's share is projected to grow to more than 30 percent by 2035.[60] China's dominance in global emissions is attributable to its rapidly growing economy (its GDP increased nearly 30-fold between 1971 and 2011), coupled with its reliance on coal for two-thirds of its total energy use, giving it a relatively high "emission intensity" (emissions per unit of GDP). Although China's emission intensity has fallen, its economy is about four times as emission intensive as that of the United States.[61]

Achieving any given reduction in global emissions would be substantially costlier without China's participation. China and other developing countries tend to have relatively inefficient energy-producing infrastructure, offering relatively low-cost opportunities to improve efficiency. Moreover, because China's energy-producing infrastructure is growing rapidly, delaying reductions could lock in emission-intensive capital equipment for decades.[62] Between 2004 and 2010, China more than doubled its capacity of coal-fired electricity generators, and although the efficiency of the Chinese coal fleet improved significantly over that period, those generators are expected to last 50 years.[63] And EIA forecasts that China will roughly double again its production of coal-fired electricity between now and 2040.[64] Finally, without similar efforts in China and other developing countries, policies to reduce U.S. emissions could trigger offsetting increases in overseas emissions—a phenomenon known as "leakage." Leakage can occur in two ways:

- U.S. emission-reducing policies raise the cost, and reduce domestic consumption, of oil and its refined products. That drop in consumption lowers the world price of oil, leading to offsetting increases in the consumption of oil and its refined products—and corresponding increases in emissions—in countries without similar restrictions.

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[60] Energy Information Administration, *China* (EIA, February 4, 2014), www.eia.gov/countries/country-data.cfm?fips=CH; and Energy Information Administration, *International Energy Outlook 2013* (July 2013), Table 21, www.eia.gov/forecasts/archive/ieo13/; International Energy Agency, *World Energy Outlook Special Report 2013: Redrawing the Energy Climate Map* (IEA, June 10, 2013), Figure 1.11, p. 30, http://tinyurl.com/nu9e3he.

[61] International Energy Agency, *CO_2 Emissions From Fuel Combustion, Highlights 2013* (IEA, 2013), http://tinyurl.com/ogt35u3 (based on exchange rate–adjusted GDP).

[62] For example, see Valentina Bosetti, Carlo Carraro, and Massimo Tavoni, "Climate Change Mitigation Strategies in Fast-Growing Countries: The Benefits of Early Action," *Energy Economics*, vol. 31, suppl. 2 (December 2009), pp. S144–S151, http://dx.doi.org/10.1016/j.eneco.2009.06.011.

[63] Citibank, *The Unimaginable: Peak Coal in China* (September 4, 2013), http://tinyurl.com/qxffvcl (PDF, 837 KB).

[64] Although the EIA base case scenario projects China doubling coal consumption by 2040, some analyses project slower economic growth in China and suggest that coal consumption in China could peak by 2016 and fall shortly thereafter. See, for example, International Energy Agency, *World Energy Outlook 2013* (IEA, November 12, 2013), pp. 4–5, www.worldenergyoutlook.org/publications/weo-2013/. For the EIA analysis, see Energy Information Administration, *China* (February 4, 2014), www.eia.gov/countries/cab.cfm?fips=CH.

- U.S. emission-reducing policies also raise the cost of producing emission-intensive goods and services, such as chemicals and aluminum. Manufacturers could seek to avoid those higher costs by relocating their production—and their emissions—to countries with less stringent policies.[65]

Leakage to China through the first mechanism might be limited to the extent that China's price controls prevent consumers' prices from falling in response to decreases in the world price of oil. Leakage through the second mechanism is of concern because China tends to be a relatively low-cost location for manufacturing.[66]

IV. Policy Options to Limit Effects on U.S. Households and Businesses

China's growing energy use could raise oil prices, increase oil price volatility, and increase emissions of greenhouse gases. U.S. policymakers might consider several options to minimize such effects. Some such options might benefit U.S. households and businesses regardless of China's energy consumption. For example, most oil in the United States is refined to make gasoline or diesel, and few substitutes for fueling transportation exist. Policymakers could reduce the effect on U.S. consumers of higher and more volatile oil prices by increasing consumers' alternatives for transportation. Other policies could decrease demand for oil or increase the supply of oil on the market. The benefits of those policies would accrue to U.S. consumers regardless of which countries contributed to higher oil prices or to increased oil price volatility, but the policies would have costs as well.

Current domestic energy policy in China includes direct and indirect subsidies for renewable technologies as well as energy price controls that subsidize the manufacturing of energy-intensive goods and services. Those policies make some U.S. businesses less competitive but also benefit U.S. consumers and in some instances may lower greenhouse gas emissions. The most direct counterbalance to Chinese subsidies could be countervailing duties on Chinese imports or subsidies for domestic manufacturing. However, countervailing duties are already in place for some imports, and subsidizing U.S. manufacturing might violate agreements the United States has made through the World Trade Organization (WTO) or could introduce competitive disparities with other countries. Subsidies would also be expensive for the U.S. government. Alternatively, engaging China through WTO could encourage China to reduce its subsidies or transition more quickly to market prices for energy to reduce any competitive disadvantage for U.S. firms. Also, policies that encouraged expanded partnership with Chinese firms could better leverage any innovation obtained as a result of the large Chinese government subsidies for those industries. Separately, to capitalize on growing Chinese demand for coal and natural gas, policymakers might consider options to enable exporting coal and natural gas to China. Such export capacity would benefit the owners and employees of coal and natural gas resources regardless of the destination country, although entering into long-term contracts with Chinese buyers may also confer benefits.

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[65] For a more extensive discussion, see Congressional Budget Office, *Border Adjustments for Economywide Policies That Impose a Price on Greenhouse Gas Emissions* (December 2013), www.cbo.gov/publication/44971.

[66] See Energy Information Administration, *China* (February 4, 2014), www.eia.gov/countries/cab.cfm?fips=CH.

A final set of potential options would encourage China to reduce emissions of greenhouse gases. Such strategies could include subsidizing emission reductions by offering technical assistance to Chinese companies. Alternatively, U.S. policy could allow China to sell "credits" for emission reductions that it makes. U.S. businesses seeking voluntary emission reductions or required to comply with a carbon tax or a cap-and-trade program that requires firms to hold tradable rights (called allowances) for their emissions would purchase such credits. Finally, the United States could implement border adjustments that would penalize China and other countries that fail to enact emission-reducing policies comparable to those in the United States.

Policies to Reduce Exposure to Higher Oil Price Levels or Volatility

China's growing consumption of oil puts upward pressure on the price of oil. China's financial support for increased oil production from Africa also increases oil price volatility, in contrast to a world in which all increased production comes from stable countries such as the United States or Canada. Those effects, in turn, are seen in the markets for products made from oil—namely, gasoline and diesel. To reduce exposure to unexpected changes in those prices, policymakers could give U.S. consumers of oil more alternatives if the price of oil increased. Such policies might encourage alternatives to personal vehicle use or vehicles that could run on alternative fuels. To lower the world oil price, policymakers might also consider ways to reduce the demand for refined oil products or increase the supply of oil. Policies to reduce demand might include increased fuel efficiency or incentives to drive less; policies to increase supply might include expanded drilling for oil in the United States or the development of fuels that substituted for oil.[67]

Increase Consumers' Flexibility When Oil Prices Rise. Policies that promote alternatives to petroleum-fueled vehicles would reduce U.S. consumers' vulnerability to increases in oil prices. Such policies might include increasing the availability of public transportation or reducing the need to use personal vehicles. Important determinants of whether people use public transportation are the price of the trip, door-to-door travel time, and reliability of service.[68] To address those factors, policies could offer subsidies to reduce fares or to promote more frequent operation (beyond peak travel hours, perhaps with firms offering more flexible working hours) of existing rail, subway, bus, and tram service. Such changes could motivate consumers to use public transportation more when oil prices increased. And with sufficient staffing and finances, those changes could be implemented quickly.

Increasing capacity for public transportation could be costly. Constructing new fixed-track public transportation alternatives (such as rail and subway lines) would require significant time and money. A cheaper alternative would be to expand existing transit systems, such as by adding new bus service or increasing the number and locations of bus stops. Not all communities would be appropriate locations for

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[67] For additional policy options to address volatility in oil markets, see Congressional Budget Office, *Energy Security in the United States* (May 2012), www.cbo.gov/publication/43012.

[68] See Daniel McFadden, "The Measurement of Urban Travel Demand," *Journal of Public Economics*, vol. 3, no. 4 (November 1974), pp. 303–328, http://dx.doi.org/10.1016/0047-2727(74)90003-6; and Brian D. Taylor and others, "Nature and/or Nurture? Analyzing the Determinants of Transit Ridership Across U.S. Urbanized Areas," *Transportation Research Part A: Policy and Practice*, vol. 43, no. 1 (January 2009), pp. 60–77, http://dx.doi.org/10.1016/j.tra.2008.06.007.

public transportation offerings, however, particularly those in areas with a geographically dispersed population. Those areas might be better suited to policies that encouraged telecommuting or sharing rides to work, both of which would reduce consumption of oil. Such policies would decrease fuel use by prompting some consumers to not drive. In addition, the policies could be implemented quickly (although not all at the federal level). Although such policies would allow some households and businesses to spend less when oil prices rose, the policies might cause inconvenience or longer commutes.

A second type of policy to increase the flexibility of U.S. consumers would promote alternative-fueled vehicles (natural gas or electric), federal support for high-speed electric rail, or new alternative-powered public transportation. By diversifying the transportation sector's energy sources, those policies would reduce vulnerability to changing world oil prices for consumers shifting from oil-based transportation—as well as for consumers who would still ordinarily use oil—by offering alternatives that do not depend on oil. Some limited steps have already been taken to diversify fuel use for transportation; for example, municipal vehicles rely increasingly on natural gas.

Some policies to develop alternative-fueled vehicles could require significant investments in infrastructure and technology development and thus might not produce a positive return for many years, if at all. Both developing a distribution network to deliver natural gas to vehicles and building high-speed rail would have high capital costs, at least some of which taxpayers would probably have to bear. In addition, as the transportation sector came to rely more heavily on other commodities, such as natural gas, those commodities could increase in cost, which might raise costs for consumers in other energy-consuming sectors of the economy.

Reduce Demand for or Increase Supply of Oil. Policies to reduce demand for oil—such as raising fuel-efficiency requirements for passenger vehicles and trucks, increasing the tax on gasoline and diesel, and lowering the speed limit (slower driving reduces fuel consumption per mile)—could reduce the vulnerability of U.S. households and businesses to higher oil prices.[69] Alternatively, policies to increase domestic production of oil could offset some of China's growing demand and lower world oil prices from what they would have been without the additional production. Such policies could include opening more of the Outer Continental Shelf or the Arctic to drilling, expediting regulatory approval of applications to drill, or reducing the fees charged to private firms (for example, the royalties paid to the government for each barrel of oil produced) when the government makes oil underlying federal lands available for extraction.[70]

[69] The Government Accountability Office reports that the establishment in 1974 of a national speed limit of 55 miles per hour decreased U.S. fuel consumption by 0.2 percent to 3 percent, which the Department of Energy estimates saved 175,000–275,000 barrels of oil per day; a reduction of 5 miles per hour in speed increases fuel economy by 5 percent to 10 percent. See Government Accountability Office, *Energy Efficiency: Potential Fuel Savings Generated by a National Speed Limit Would Be Influenced by Many Other Factors*, GAO-09-153R (November 7, 2008), www.gao.gov/products/GAO-09-153R.

[70] The Outer Continental Shelf is the submerged land, subsoil, and seabed off the U.S. coast at a distance between state jurisdiction (typically 3–5 nautical miles offshore, depending on the state) and 200 miles offshore.

On the demand side, higher fuel-efficiency standards would require new vehicles that use less fuel per mile, reducing the exposure of U.S. consumers to increases in oil prices.[71] An increase in the tax on gasoline and diesel would raise the cost of consuming oil-based fuels, offering households and businesses a financial incentive to find long-run alternatives to consuming such fuels. Policies to increase taxes could be implemented more quickly than policies to increase fuel-efficiency standards. Near-term responses to a higher fuel tax (or to higher gasoline and diesel prices that occur for other reasons) could include shifting to more fuel-efficient vehicles when they are available, carpooling, driving more slowly, or vacationing closer to home. Long-run responses could include buying smaller, more fuel-efficient vehicles; living closer to work or public transit; or selecting jobs on the basis of their telecommuting options.

On the supply side, some policies could probably increase the amount of oil produced and brought to the world market, lowering world oil prices from what they would have been without the increase in production. The magnitude of the price reduction would depend on the additional volume of oil produced, changes in oil demand around the world, and changes in supply by other countries. In some instances, prices may change little despite increased production. To illustrate: Between January 2011 and July 2014, U.S. domestic production of crude oil increased by 4 million barrels per day, more than a 70 percent increase. Oil prices, however, remained relatively flat through July 2014 for three reasons.[72] First, demand for oil from China, India, Brazil, and Russia grew by about 2 million barrels per day, and thus, even large changes in the U.S. supply were met in part by growing global demand. Second, unrest in Libya, Nigeria, Iraq, and elsewhere reduced the supply of oil by more than 2 million barrels per day. Third, in response to higher U.S. oil production and projections for weaker demand, some members of the Organization of Petroleum Exporting Countries reduced production to maintain stable world oil prices. Most notably, Saudi Arabia reduced production toward the end of 2012 and early 2013 by about 700,000 barrels per day.[73]

Between July 2014 and January 2015, U.S. oil production grew by an additional 700,000 barrels per day and world oil prices fell by more than $50 per barrel. Several factors contributed to that decline, including lower than expected demand from Europe and Asia, increased production from Libya, and steady production from Iraq and other areas in the Middle East that analysts had thought would be disrupted by unrest in the region. In addition, in November 2014, Saudi Arabia decided against reducing oil production

[71] In April 2010, the National Highway Traffic Safety Administration and the Environmental Protection Agency finalized a rule to increase corporate average fuel economy standards for light-duty vehicles (including cars, sport utility vehicles, pickup trucks, minivans, and crossover vehicles) from 29.7 miles per gallon (mpg) in 2012 to 34.1 mpg by 2016. Then in 2011, they issued a joint proposed rule that would further tighten corporate average fuel economy standards for those vehicles—to 49.6 mpg—from 2017 through 2025. A first set of fuel efficiency standards for medium- and heavy-duty vehicles was finalized in September 2011 and set standards for 2014–2018. The President has directed EPA and the Department of Transportation to develop the next phase of those standards. A proposed rule is expected in 2015.

[72] Energy Information Administration, "U.S. Liquid Fuels Production Growth More Than Offsets Unplanned Supply Disruptions," *Today in Energy* (August 27, 2014), www.eia.gov/todayinenergy/detail.cfm?id=17731.

[73] Amena Bakr, "Update 4—Saudi Arabia Cuts Oil Output as Demand Eases," *Reuters* (January 10, 2013), http://tinyurl.com/muq52g9. The CEO of Saudi Arabia's national oil firm stated that they would reduce planned output capacity expansion given "massive capacity expansions coming out of countries like Brazil [and] Iraq." See Summer Said, "Saudis See No Reason to Raise Oil Output Capacity," *Wall Street Journal* (October 10, 2011), http://tinyurl.com/nge3gas.

to bolster oil prices. Some observers described that as a strategic decision that satisfied a variety of Saudi Arabian objectives, even if not achieving stable oil prices.[74]

Regardless of the effect on world oil prices, greater domestic production could reduce the exposure of some consumers to higher price levels in oil markets. Firms that produce oil earn profits on that production, and thus greater U.S. production of oil would increase those profits. To some extent, those profits would return to U.S. consumers as dividends, higher salaries and wages for workers in oil-producing firms, and increased domestic investment in oil production and processing. Those profits also would be distributed to stockholders and used for investments outside the United States. For people who buy fuel for transportation but do not receive financial benefits from the firms producing oil, policies to promote increased production would tend to redistribute more wealth from consumers of transportation fuel to shareholders and employees of firms that produce oil.

One argument against increasing domestic production is that doing so in the near term decreases capacity to produce oil farther in the future, when prices might be even higher and when households and businesses might value even more highly the ability to reduce those prices. Consumption of oil by India and Brazil is also expected to rise by a percentage comparable to that of China between 2014 and 2040.[75] Such growth in world consumption will continue to put upward pressure on oil prices (unless sufficient new sources of oil are identified and developed), increasing the value of oil inventories regardless of whether that oil is held above ground or left underground in its original reservoirs. Thus, by not developing all its oil resources now, the United States retains more flexibility should oil prices rise dramatically.

Another type of policy on the supply side is to develop alternative fuels—ones that can be mixed with or can replace gasoline and diesel—which could also reduce U.S. consumers' vulnerability to changes in oil prices. Examples of such policies include subsidies to develop natural gas resources, biofuels, or coal gasification, as well as regulations that require the use of alternative fuels, such as the Renewable Fuel Standard, which requires increasing amounts of renewable fuels to be included in the nation's transportation fuel supply.[76] (Some alternative fuels, such as ethanol, are blended with gasoline or diesel. Others, such as coal or natural gas, can be chemically converted to gasoline or diesel.) Persistent disruptions in oil markets could be partially or fully offset if domestic firms decided to expand their capacity to produce alternative transportation fuels, particularly those that have the chemical properties of their petroleum-based counterparts and can readily replace oil-based transportation fuels. Nevertheless, the economic feasibility and the consequences of enacting policies to promote alternative fuels are

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[74] See "The Economist Explains: Why the Oil Price is Falling," *Economist* (blog entry, December 8, 2014), http://tinyurl.com/kfk9y4y; and "The New Economics of Oil: Sheikhs v Shale," *Economist* (December 6, 2014), http://tinyurl.com/klhxbej.

[75] See Energy Information Administration, *International Energy Outlook 2011* (September 19, 2011), www.eia.gov/forecasts/archive/ieo11/.

[76] Coal gasification is a process that converts solid coal—through several energy-intensive steps—into gasoline and diesel fuel. Natural gas is also convertible to gasoline through a similar, energy-intensive process.

uncertain. Converting coal, natural gas, and organic matter to gasoline is currently expensive, inefficient, and unproven on a large scale.[77]

Policies to Increase U.S. Competitiveness in Manufacturing

To address Chinese subsidies that lower the cost of producing internationally traded goods and services, policies could increase the competitiveness of U.S. firms trading in those markets. Although the United States already imposes countervailing duties on some goods, one policy option might provide subsidies to enhance U.S. competitiveness or impose additional tariffs on Chinese imports. However, subsidies would be expensive and may be subject to challenges at the World Trade Organization, and tariffs raise prices for U.S. consumers. Moreover, the trade remedies already in place for some goods may be able to address competitiveness issues in the related domestic market. Policies to encourage China to reduce or eliminate its subsidies of Chinese goods and services would improve efficiency, although policies that reduced the use of renewable technologies would result in higher greenhouse gas emissions. In some markets, particularly those for renewable energy technologies, the United States could advocate policies that increased cooperation with China such that U.S. business could benefit from Chinese subsidies to research and development. Finally, policies that increased coal and natural gas exports could make the producers of those energy commodities in the United States more competitive.

Offer Subsidies for U.S. Manufacturing or Levy Tariffs on Chinese Imports. One approach to counter Chinese energy subsidies is to offset them either with equal energy subsidies for U.S. manufacturing firms or with additional countervailing duties on Chinese imports. A subsidy strategy applied broadly to U.S. goods that compete with Chinese imports could be expensive for U.S. taxpayers. In 2013, estimated Chinese energy subsidies were $11.8 billion for oil, $2 billion for natural gas, and $7.2 billion for electricity.[78] Equal subsidies for electricity and coal would be expensive for taxpayers and could break WTO guidelines for fair trade. Such subsidies would also probably result in countervailing-duty actions against U.S. exports. And although subsidies for U.S. firms might create a more competitive balance with China, they would introduce disparities with other countries that export goods and services into the same markets.

[77] For more details on the costs and feasibility of biofuels, see Congressional Budget Office, *The Renewable Fuel Standard: Issues for 2014 and Beyond* (June 2014), www.cbo.gov/publication/45477, and *Using Biofuel Tax Credits to Achieve Energy and Environmental Policy Goals* (July 2010), www.cbo.gov/publication/21444. Producing biofuels also raises the cost of food; see Congressional Budget Office, *The Impact of Ethanol Use on Food Prices and Greenhouse Gas Emissions* (April 2009), www.cbo.gov/publication/41173. And increased reliance on biofuels introduces weather uncertainty into considerations of crop yields from one year to the next; see Darrel Good and Scott Irwin, *2007 U.S. Corn Production Risks: What Does History Teach Us?* Marketing and Outlook Brief 07-01 (Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign, May 2007), http://tinyurl.com/m6pqpu8.

[78] The Chinese government has relaxed some of its energy price controls since 2012, which may mean that those subsidy levels would be lower in the future. For more information on energy subsidies in China, see International Energy Agency, "Fossil-Fuel Consumption Subsidy Rates as a Proportion of the Full Cost of Supply, 2013" (2014), www.iea.org/subsidy/. Consistent with the magnitude of those numbers, energy subsidies for steel have been estimated at $27 billion between 2000 and 2007; see Usha C.V. Haley and George T. Haley, *Subsidies to Chinese Industry: State Capitalism, Business Strategy, and Trade Policy* (Oxford University Press, 2013), http://tinyurl.com/lrjm669.

The U.S. Department of Commerce has investigated Chinese government energy subsidies in countervailing-duty proceedings that U.S. workers and industries have filed under provisions of U.S. law. Those proceedings resulted in tariffs imposed on Chinese imports in selected sectors to offset the loss from Chinese energy subsidies. Antidumping and countervailing duties, or tariffs, have been levied on Chinese solar panels and wind towers; the European Commission has also levied its own antidumping and countervailing tariffs on Chinese solar panels.[79] Countervailing duties imposed on Chinese solar panels add between 15 percent and 50 percent to their price, and tariffs of 22 percent to 35 percent have been added to Chinese wind towers.[80] China has challenged the legality of those countervailing duties under WTO rules.[81] Countervailing duties or tariffs would not affect U.S. competitiveness in countries that had not also applied their own trade remedies to address Chinese subsidies, in which case U.S. exports would still be less competitive than Chinese exports.

Some argue that such U.S. subsidies or countervailing duties are important to support a continuation of U.S. solar and wind industries and to ensure competition in those industries to keep prices from increasing in the future. Those arguments suggest that more innovation occurs in the United States, which makes U.S. participation in those industries good for world consumers. Conversely, an argument against this option is that the current process for imposing countervailing duties is sufficient to offset the loss in competitiveness that results from subsidies given by foreign governments.

Engage China Through the World Trade Organization. By reducing or eliminating subsidies for renewable technologies or subsidies based on price controls, China would lose any associated cost advantages. U.S. manufacturing firms could then more easily trade internationally, making the market for traded goods more efficient. Policies might include making the removal of such subsidies a priority for U.S. trade negotiators or pursuing lawsuits regarding unfair trade practices through the World Trade Organization.[82] The cost of such actions is the lost opportunity to pursue other objectives in negotiations with China, as well as the increases in greenhouse gas emissions that would result.

Over the past few years China has reduced or eliminated price controls on some energy commodities, most notably oil and natural gas. Recent attempts to harmonize Chinese oil prices with international prices seem to have succeeded, and natural gas prices in China have increased toward the market price. But China has done less to remove price controls in electricity markets, instead developing more incentives to encourage firms to adopt energy-efficiency measures. China's delay in reforming electricity prices might be due to uncertainty about how to transition to market-based electricity pricing that ensures

[79] Timothy Meyer, "Energy Subsidies and the World Trade Organization," *Insights*, American Society of International Law, vol. 17, no. 22 (September 2013), http://tinyurl.com/nxkdf7x.

[80] The range is based on two countervailing-duty determinations by the U.S. Department of Commerce on December 16, 2014, and October 10, 2012. See http://enforcement.trade.gov/frn/.

[81] See World Trade Organization, "United States—Countervailing Duty Measures on Certain Products From China," Dispute DS437 (January 16, 2015), www.wto.org/english/tratop_e/dispu_e/cases_e/ds437_e.htm.

[82] Between 2010 and 2013, four WTO disputes challenged subsidies for renewable energy firms. To date, no one has challenged fossil fuel energy subsidies directly at the WTO, but they are under consideration as a subsidy with "harmful environmental consequences." For more information, see Timothy Meyer, "Energy Subsidies and the World Trade Organization," *Insights*, American Society of International Law, vol. 17, no. 22 (September 2013), http://tinyurl.com/nxkdf7x.

stable growth in electricity production. If so, the United States could offer China technical assistance based on domestic experience. With a market price for electricity, domestic manufacturers would have an incentive to pursue energy-efficiency measures on their own. The prices for their goods and services would then reflect the energy intensity of their manufacturing process compared with that of competing firms, regardless of country of origin.

Support the Development of Expanded Partnerships With Chinese Companies. Chinese investment in developing renewable technologies creates innovation and economies of scale in renewable energy technologies. In an open economy, that innovation would first benefit the company responsible for it but would eventually disperse across all companies in the industry. That might happen when employees change jobs, firms merge or are acquired, or patents expire. The Chinese economy is less open to trade in intellectual property than the U.S. economy, which might reduce the speed or extent to which some of those benefits accrue to U.S. firms. Therefore, policies that encouraged U.S. and Chinese firms to collaborate could improve the ability of U.S. firms to benefit from Chinese subsidies of renewable technology firms.

One such collaboration is the U.S.-China Clean Energy Research Center, established in 2009 to spur innovation in renewable energy and energy efficiency.[83] It was funded with $150 million from both China and the United States divided across five years. By August 2013, the endeavor involved 86 Chinese organizations and 41 U.S. organizations. Although the program appears to make demonstration projects more likely, it has been less successful in creating a model to develop shared intellectual property. Analysts suggest that more experience and additional partnerships will reduce such challenges.

The propensity of U.S. firms to engage in such partnerships would depend on the benefit U.S. firms receive. To participate, U.S. firms must believe that any benefit would more than offset concerns about the security of intellectual property rights in China.[84] Since multinational firms are present in China, U.S. firms would also probably expect some transferrable innovations to spread on their own to other countries and the United States.

Support the Development of Facilities to Export Natural Gas and Coal. Despite the cost of shipping U.S. natural gas and coal to China, the price differences for those commodities between the countries suggest that some trade could be profitable for U.S. natural gas or coal facilities. Some countries with large energy reserves, such as Qatar and Australia, have developed significant capacity to ship their energy commodities abroad. In the United States, exporting natural gas and coal requires federal construction permits and export permits.[85] Policies that eased permitting requirements or reduced the time

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[83] For more, see Joanna I. Lewis, "Managing Intellectual Property Rights in Cross-Border Clean Energy Collaboration: The Case of the U.S.–China Clean Energy Research Center," *Energy Policy*, vol. 69 (June 2014), pp. 546–554, http://dx.doi.org/10.1016/j.enpol.2013.12.053.

[84] For more on concerns by U.S. firms about intellectual property rights in China, see Titus O. Awokuse and Hong Yin, "Intellectual Property Rights Protection and the Surge in FDI in China," *Journal of Comparative Economics*, vol. 38, no. 2 (June 2010), pp. 217–224, http://dx.doi.org/10.1016/j.jce.2009.10.001; and "Does Stronger Intellectual Property Rights Protection Induce More Bilateral Trade? Evidence From China's Imports," *World Development*, vol. 38, no. 8 (August 2010), pp. 1094–1104, http://dx.doi.org/10.1016/j.worlddev.2009.12.016.

[85] As of March 2015, roughly 30 applications that have sought full approval to export liquefied natural gas are still awaiting approval. Several new coal export facilities on the West Coast are also seeking permit approval. For natural

to receive permits would probably improve the global competitiveness of U.S. firms that own natural gas and coal resources, independent of the trading partner.

The potential to develop and use additional export capacity differs for natural gas and coal. Growing demand for natural gas, as China shifts from coal, combined with growing U.S. production of natural gas suggests that price differences for natural gas between the countries may persist for the foreseeable future. That would make expanding export capacity valuable for firms that own natural gas resources. As of 2014, only a few U.S. facilities can liquefy natural gas and export it. However, the Department of Energy and the U.S. Maritime Administration have approved exports from eight LNG facilities, enabling them to export about 10 billion cubic feet of natural gas per day (about 0.03 percent of 2013 production). But only four of those facilities have received approval for construction, and of those, only one is under construction.[86] Conversely, coal prices in China have fallen, partly because mines continue to produce coal at increasing rates owing to government subsidies and partly because of slower growth of coal consumption. For imported coal, China also recently imposed tariffs that will probably make imported U.S. coal less attractive.[87] The United States has capacity to export 279 million tons of coal per year; over the past five years total actual exports have averaged around 100 million tons.[88] Although the West Coast is closer to China, it has capacity to export only 9 million tons of coal per year—so most coal exported to China in 2012 came from non–West Coast ports. In late 2014, the State of Oregon denied a permit for a new export facility that would have had a capacity of 8 million tons per year; however, state agencies in Washington are still considering two permits for a combined capacity increase of 91 million tons per year.[89]

Building a large export capacity has two potential downsides for U.S. households and businesses. First, those facilities tend to be expensive to build and typically require long-term contracts to justify their operation. By developing natural gas domestically or reducing their imports of coal, China and other countries would be less willing to buy more expensive LNG or coal from the United States. That scenario could be costly for firms that invest in the LNG or coal export facilities. Second, as the United States builds more export capacity, the U.S. price of natural gas and coal becomes increasingly connected to the Asian price for those commodities. (Such interconnection would require significantly more U.S. export capacity than is currently approved for both natural gas and coal.) If that were to happen, profits of U.S. producers of natural gas and coal would probably increase, but U.S. consumers would probably pay more

gas, see Department of Energy, "Summary of LNG Export Applications of the Lower 48 States" (March 26, 2015), http://go.usa.gov/3DgMe.

86 Congressional Budget Office, *The Economic and Budgetary Effects of Producing Oil and Natural Gas From Shale* (December 2014), www.cbo.gov/publication/49815.

87 Fayen Wong, "Update 2—China to Again Levy Coal Import Tariffs After Nearly a Decade," *Reuters* (October 9, 2014), http://tinyurl.com/k5y3sg5.

88 National Mining Association, "Existing and Potential Coal Export Infrastructure" (accessed February 24, 2015), http://tinyurl.com/o8lspzz (PDF, 106 KB); Energy Information Administration, "Coal Data Browser," (accessed February 24, 2015), www.eia.gov/beta/coal/data/browser/.

89 For information on the decision to reject the permit in Oregon for Coyote Island Terminal, see the State of Oregon website (www.oregon.gov). For more information on Washington State's pending permits for Millennium Bulk Terminal or Gateway Pacific Terminal, see Washington Department of Ecology (www.ecy.wa.gov).

for natural gas and electricity. U.S. consumers would also become increasingly exposed to the effects of supply disruptions occurring outside the United States, similar to what occurs with supply disruptions in oil markets.

Policies to Reduce Greenhouse Gas Emissions

The United States and China recently agreed to limit greenhouse gas emissions. The United States set an economywide target to reduce its emissions by 26 percent to 28 percent below its 2005 level in 2025. China, in turn, set the goal of having its carbon dioxide emissions peak around 2030.[90]

China has enacted policies to reduce its greenhouse gas emissions—most notably, seven pilot programs for a national cap-and-trade program. Those pilot programs cover activities that account for about 7 percent of China's total emissions.[91] Evaluating the effectiveness of China's programs is challenging for many reasons, including a paucity of emissions reporting, lack of transparency about the emissions caps, and uncertainty about the programs' legal foundation and enforcement policies.[92]

Researchers have explored options that would induce China to undertake greater emission reductions than it would under existing, or planned, programs (referred to as "additional" reductions). Such strategies could help to ensure that China meets, or exceeds, its goal of having its emissions decline after 2030. Possibilities include subsidizing reductions by offering technical assistance, allowing China to sell "credits" for emission reductions that it makes, and implementing border adjustments that would penalize China and other countries that fail to enact emission-reducing policies comparable to those in the United States.

Offer Technical Assistance to China. Climate change is a long-term problem; realizing the benefits of reducing emissions takes decades. China's interest in those long-term benefits may be mitigated by its primary goal of raising its citizens' standard of living (despite China's rapid growth, its per capita income is roughly one-eighth that of the United States).[93] Therefore, the United States could encourage China to make additional reductions by offering technical assistance that lowers the cost of achieving them—although that assistance itself would entail some costs to U.S. taxpayers. Such assistance may work best if it also helps China achieve other near-term goals. Technical assistance could be targeted at measures that not only reduce carbon dioxide (CO_2) emissions but also enhance innovation, create jobs, reduce local air pollution, or improve the reliability of electricity provision. An exhaustive list is beyond the scope of this paper, but researchers have suggested areas in which technical assistance could both reduce CO_2 emissions and help China achieve near-term goals:

[90] The White House, "U.S.-China Joint Announcement on Climate Change" (press release, November 12, 2014), http://go.usa.gov/3DYsP.

[91] International Energy Agency, *Medium-Term Coal Market Report 2013* (IEA, November 2013), p. 82, http://tinyurl.com/pmfhjcx.

[92] Clayton Munnings and others, *Assessing the Design of Three Pilot Programs for Carbon Trading in China*, RFF Discussion Paper 14-36 (Resources for the Future, October 2014), http://tinyurl.com/legz8r6.

[93] Based on 2012 data from the World Bank: The World Bank "GDP Per Capita (Current US$)" (2014), http://data.worldbank.org/indicator/NY.GDP.PCAP.CD.

- *Technology development and diffusion.* Some researchers advise that the United States and China could find it advantageous to work together to develop emission-reducing technologies because the two countries have complementary strengths in technology development. For example, the United States has an advantage in moving breakthroughs from research to commercialization, whereas China has greater knowledge about what will work in developing countries. Building on those strengths, a variety of policy proposals address how developed countries might work with developing countries to improve energy efficiency.[94] Moreover, because China's energy infrastructure is rapidly expanding, it can offer opportunities to test new technologies or to deploy existing low-emission technologies, such as carbon capture and storage technology, nuclear power, or natural gas obtained by fracking.[95] In 2009 the United States and China reached several technology agreements, yet the United States has provided only limited funding to implement them.[96]

- *The phaseout of energy subsidies.* Many developing countries subsidize energy consumption to achieve social stability, to enable access to cleaner cooking fuels, to increase electrification, or as part of an industrial policy. However, such subsidies encourage overconsumption of fossil fuels and increase CO_2 emissions. Eliminating such subsidies would reduce emissions of both CO_2 and sulfur dioxide (SO_2), a pollutant causing severe local health problems in China. Some researchers suggest that the United States could encourage China to reduce, or eliminate, such subsidies by offering financial or technical assistance to implement policies (such as per capita rebates) that would cushion the effects of the subsidy withdrawal or otherwise achieve the subsidies' goals.[97]

- *Improvements in energy efficiency.* Energy use per dollar of GDP is roughly four times higher in China than in the United States. [98] In addition to reducing CO_2 emissions, improvements in energy efficiency could help China reduce SO_2 emissions and might help China prevent power outages that might otherwise occur because of a mismatch between China's available supply of, and rapidly growing demand for, electricity.[99] The United States has experience in standard setting and emissions monitoring that has substantially decreased U.S. emissions of SO_2 as well as improved efficiency of electricity production.

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94 Daniel S. Hall and others, *Policies for Developing Country Engagement*, Harvard Project on International Climate Agreements Discussion Paper 08-15 (Belfer Center for Science and International Affairs, October 2008), http://tinyurl.com/ntnaxg9.

95 Congressional Budget Office, *Federal Efforts to Reduce the Cost of Capturing and Storing Carbon Dioxide* (June 2012), www.cbo.gov/publication/43357.

96 Joshua W. Busby, *China and Climate Change: A Strategy for U.S. Engagement* (Resources for the Future, November 2010), http://tinyurl.com/32kwncy.

97 Daniel S. Hall and others, *Policies for Developing Country Engagement*, Harvard Project on International Climate Agreements Discussion Paper 08-15 (Belfer Center for Science and International Affairs, October 2008), http://tinyurl.com/ntnaxg9.

98 International Energy Agency, *CO_2 Emissions From Fuel Combustion, Highlights 2013* (IEA, 2013), http://tinyurl.com/ogt35u3 (based on exchange rate–adjusted GDP).

99 Olivia Boyd, *China's Energy Reform and Climate Policy: The Ideas Motivating Change*, Centre for Climate Economics and Policy Working Paper 1205 (Crawford School of Public Policy, Australian National University, May 2012), https://ideas.repec.org/p/een/ccepwp/1205.html.

- *Tax reform.* Some researchers suggest that China could impose a tax on CO_2 emissions and use the revenue to lower existing taxes that reduce the level of investment by businesses. Such a "tax swap" would reduce CO_2 emissions—and substantially improve local air quality—perhaps without reducing China's economic growth.[100] The United States, in turn, has a sophisticated system of tax collection and has studied the efficiency and distributional effects of policies that would put a price on CO_2 emissions. Such expertise could be useful to Chinese researchers and policy officials.

Offer Credits for Emission Reductions in China. A U.S. policy to price CO_2 emissions—by either taxing them or establishing a cap-and-trade program—could create an incentive for U.S. firms to fund emission reductions in China. In that scenario, U.S. firms could purchase "credits" for additional reductions made in China and use those credits as a way to comply (in lieu of paying the tax or purchasing an allowance for each ton of CO_2 that U.S. firms emit). For example, such credits could fund efforts to improve efficiency in Chinese manufacturing facilities. Or the credits could fund the incremental cost to build and operate power plants fired by natural gas rather than by coal, which has nearly twice the CO_2 emissions of natural gas and accounts for roughly two-thirds of China's energy consumption.[101] China and other developing countries have generated such credits to sell to countries that have established binding emission caps under international climate change agreements; however, some researchers have questioned how much such credits have reduced emissions (beyond what would have occurred without them).[102] Researchers have suggested reforms that might help ensure that credits are provided only for measurable, additional emission reductions. For example, granting credits for emission-reducing measures of an entire industrial sector (rather than an individual firm or facility) might simplify the task of assessing whether emission reductions are additional.[103]

Establish Border Adjustments. A U.S. policy that places a price on greenhouse gas emissions could include "border adjustments," which would impose a comparable price on emissions associated with imports. For a carbon tax, the adjustments might take the form of import tariffs based on estimates of the greenhouse gases emitted in producing traded products. For a cap-and-trade program, adjustments might require importers to obtain allowances for those emissions. Implementing border adjustments is challenging and the legality of them has been debated, but widespread use of them could reduce leakage and offer countries an incentive to adopt similar emission-reducing policies.[104]

[100] Chris P. Nielsen and Mun S. Ho, eds., *Clearer Skies Over China: Reconciling Air Quality, Climate, and Economic Goals* (MIT Press, 2013), http://mitpress.mit.edu/books/clearer-skies-over-china.

[101] Energy Information Administration, *China* (February 4, 2014), www.eia.gov/countries/cab.cfm?fips=CH.

[102] Lambert Schneider, "Assessing the Additionality of CDM Projects: Practical Experiences and Lessons Learned," *Climate Policy*, vol. 9, no. 3 (2009), pp. 242–254, http://dx.doi.org/10.3763/cpol.2008.0533.

[103] Dallas Burtraw and others, *Feasibility Assessment of a Carbon Cap-and-Trade System for Mexico* (Resources for the Future, July 2010), http://tinyurl.com/kc2txzt. Also, such credits would not further reduce emissions if the credits were for reductions made as a result of China's ongoing cap-and-trade programs. Linking a U.S. cap-and-trade program with one in China might reduce the total cost of achieving the combined cap on emissions; however, lax monitoring and enforcement in either country in such a linked system would undermine the credibility of both caps. See Congressional Budget Office, *Policy Options for Reducing CO_2 Emissions* (February 2008), www.cbo.gov/publication/41663.

[104] For further discussion, see Congressional Budget Office, *Border Adjustments for Economywide Policies That Impose a Price on Greenhouse Gas Emissions* (December 2013), www.cbo.gov/publication/44971.